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The Great Strike

SINCE our last issue appeared the nation has passed through an exciting experience. The general strike is now past and over. It has involved great sacrifice for everybody concerned, and it does not fall within our province to discuss its political aspects. Our present task is to put aside past misunderstandings and push ahead as rapidly as possible with the resumption of normal business conditions. However much we must all regret the loss that the strike has involved there are some compensating reflections. The calmness and courage with which this unprecedented situation was faced, the tolerance displayed by both parties to the dispute, and the comparative absence of violence and disorder have won for this country the respect of the world, and it is probable that its credit has never stood higher than it does to-day.

One thing has doubtless contributed very greatly to the general quietude and absence of panic—the fact that almost everywhere sources of artificial light were maintained. It is true that in a few districts supplies of electricity for industrial purposes were cut off, and we do not minimize the serious loss this occasioned, both to manufacturers and to their employees. But in general the public enjoyed undisturbed use of heating and lighting, and the public owes a debt of gratitude to the gas and electricity supply undertakings of this country who maintained these essential services so completely.

The dominating factor in regard to transport was the manner in which motor-driven vehicles came to the rescue when other means of conveyance ceased. Traffic authorities had to meet an unprecedented situation, which was not without its lessons for the future. For the state of important thoroughfares gave us a glimpse of what may prove to be normal conditions in a few years, if the number of cars on the road continues to increase at the present rate. It is evident that on many of these thoroughfares we are near the limit of the amount of motor-traffic that can be carried at the rush hours. In the future something may be done to lessen the crush by the creation of new arterial roads. But vigilance will be necessary if the number of street accidents, which has increased so greatly during recent years, is to be kept in check, and the need for "safety first" measures is likely to be even greater than in the past. Intimately linked with this problem is the question of street-lighting. During the strike period public lighting was not in general reduced, but the continuance of the coal strike has naturally caused apprehension, and at the time of writing somewhat severe curtailment, both of private and public lighting is being recommended. It is to be hoped that such reductions, even if rendered obligatory by progressive shrinkage in coal supplies, will be applied with discretion. Experience during the great war should be a guide to us in this respect. The diminution in public lighting on that occasion was due primarily to the necessity for precautions against visits of hostile aircraft. It was early demonstrated that the economies possible by this means were quite inconsiderable, in comparison with the disadvantages entailed. In any national emergency the preservation of adequate public lighting in the streets should be regarded as an item of the first importance—both because of its reassuring influence on the mind of the public, and in view of the safety of traffic. The vast growth in motor-transport, so vividly illustrated during the strike, only served to indicate the growing importance of this problem of public lighting. It is true that in the special circumstances that prevailed the public had not much inducement to use the streets by night, so that the great crush occurred during daylight hours. But had the strike taken place in midwinter the congestion would have occurred after dusk, and it can hardly be doubted that the difficulty of controlling this mass of traffic would have been very much greater.

It is too early as yet to visualize all the results of the strike to the lighting industry. Makers of lamps and lighting appliances have naturally been greatly impeded in deliveries to clients. In some cases even a short stoppage of transport has prevented them from obtaining essential materials. Most serious of all were the results in certain cases, such as some of the glassworks, where furnaces have been shut down. In a few cases it may even be that the results are irreparable but in most instances ultimate recovery should be rapid. Valuable trade has been lost, but with a complete return to normal conditions some at least of this may be recovered.

It is a matter for satisfaction that during the crisis journalists, with a few insignificant exceptions, carried on, and in many cases showed remarkable enterprise in devoting themselves to unfamiliar duties and enabling their periodicals to appear. Practically all weekly technical journals had to cease publication, though after the first few days the dailies were able to get out limited editions. So far as this journal was concerned we were fortunately able to publish our monthly issue on the eve of the strike. Though operations for the next issue have been somewhat held up, we hope that this also will not be unduly delayed. Normal sources of information were not all available, but we trust that our present number will equal its predecessors in interest. We desire to thank all those who, by their efforts in difficult circumstances, have enabled us to carry on.

The Optical Convention

AS indicated in our last issue we are including in this number an account of the papers read at the Optical Convention and some of the chief exhibits. The papers, over a hundred in number, fall into well-defined groups. Amongst those concerned with photometry, special interest attaches to Mr. Taylor's contribution on Portable Photometers in which the requirements of the B.E.S.A. Specification are discussed. Two suggestions are made by Mr. Taylor which may lead to greater precision, the use of a bridge method of regulating the current through the lamp, and the conception of a small internally whitened sphere with aperture, in place of the standard flat surface. These suggestions deserve careful consideration, especially the latter method of avoiding the difficulties arising from lack of perfect diffusion by all known forms of standard white test surfaces. Other papers, notably that by Mr. T. H. Harrison, deal with the possibilities of photo-electric cells. The difficulties arising in the use of such cells are admitted, but it is evident that for many researches in the photometric laboratory they have considerable value, and we are not without hope that ultimately a direct reading portable photometer based on this principle will become a practical proposition. Selenium cells, discussed by Mr. E. Fournier d'Albe, have some drawbacks as compared with the alkali photo-electric cells, but also some advantages; meantime their utility in various special fields—for instance, in apparatus for the analysis of sound and the "Optophone"—are well established. Amongst other papers of a photometric character we may note various communications dealing with standard electric lamps and the photometry of projected beams. Special interest attaches to the account of progress in the design of gasfilled electric lamps for use as sub-standards, contributed by Messrs. B. P. Dudding and G. T. Winch. Mr. J. W. T. Walsh was responsible for an informative analytical paper on the photometry of projection apparatus and the photometric treatment of projected beams was also discussed by Lieut.-Col. Silvester Evans and others.

We have next the group of papers dealing with colour, amongst which those concerned with colour problems in the textile and printing trades were of special interest. The testing of fading of dyed fabrics is now being carefully studied, and we may hope that ultimately the standardization of colours used in these and other industries will be placed on a more scientific basis. Valuable papers on colour terminology, spectrometer design and colour vision were presented by Professor Peddie, Mr. J. Guild and others.

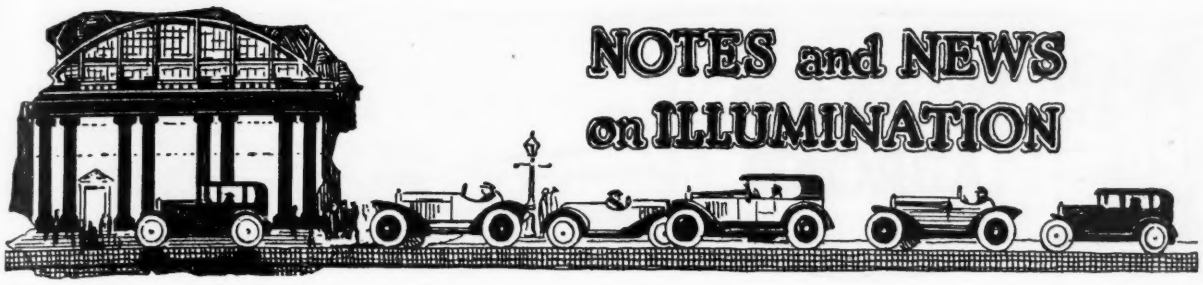
Another group of papers dealt with problems involved in kinematograph projectors. An account of two new devices designed to promote higher efficiency and diminished flicker was contributed by Mr. R. J. Trump, whilst Professor Rankine gave an instructive account of the complex problems underlying the production of "speaking films." Mr. R. J. Lythgoe and Dr. H. Hartridge described experiments illustrating the relation between illumination and acuteness of vision, and some remarks on this point are also to be found in the statistical paper contributed by Mr. Owen Aves. These, and other problems in which illuminating engineers and optical experts are jointly interested, were mentioned in the paper by the writer on "Illuminating Engineering in Relation to Optics." The summary of papers and description of exhibits (pp. 131-138) should suffice to show that the recent contributions of this country to optical research are very considerable.

The Present Position of Electric Street Lighting

A PAPER by Herr W. Wissman, read at the annual meeting of the German Illuminating Engineering Society in Münich and now published in full in *Licht und Lampe*, reviews progress in street-lighting in Germany and raises points that are the subject of discussion in several continental countries. Allusion is made to the diminished public lighting during the war. As a result of recent circularization of officials in leading towns in Germany it is concluded that only in a few towns has complete pre-war lighting yet been resumed. In many cases the lamps of smaller consumption, introduced during the war period, are still in use, giving in many cases only 50-80 per cent of the original illumination, and in some cases even less. Where formerly arc lamps of 550-825 watts were in use incandescent lamps of 200-300 watts are commonly found. Yet, as in other countries, the need for even better lighting conditions than in pre-war days, owing to the great growth in motor traffic, is generally recognized. The Committee on Street Lighting of the German Illuminating Engineering Society has accordingly increased the recommended values for average illumination in streets, the values now proposed being 1-2 lux for streets with little traffic, 2-5 lux for medium streets, and 5-20 lux* for streets with busy traffic. These values are approximately double those formerly recommended.

Of greater interest than the choice of illuminants, however, is the view expressed by Herr Wissmann in regard to street-lighting fittings. Hitherto, in discussions in street-lighting, considerable importance has been attached to the provision of comparatively uniform illumination between posts. The maintenance of a specified minimum illumination in a street is a sound principle, and it must be admitted that there is something unsatisfactory about methods which permit variations as high as 50 or even 100 to 1. At the same time we should be careful, in aiming at extreme uniformity, not to introduce other worse defects. Herr Wissmann condemns the use of very shallow reflectors (*Flachstrahler*), with the idea of allowing a maximum of light to be emitted, unobstructed, at angles slightly below the horizontal. Such units may be favourable to uniformity, but the drawback of allowing unscreened filaments to be visible to the eyes of drivers and pedestrians outweighs this advantage. There is much more to be said for the use of scientific prismatic glassware which, whilst accentuating the light at angles slightly below the horizontal, also diffuses the light. On the Continent, however, there now appears to be a considerable body of opinion in favour of the use of concentrating units (*Steilstrahler*) whereby the source can be completely hidden. Such units may be mounted at a comparatively low height, with the result that the volume of light directed on the pavement and roadway is much increased, though doubtless the degree of uniformity is impaired. It is satisfactory to observe that street-lighting is being studied closely on the Continent. It is being investigated by a committee working under the B.E.S.A. in this country, and also by a special committee in the United States, where developments in public lighting have recently been of special interest. We may hope, therefore, that at the next gathering of the International Illumination Commission a good opportunity of reviewing the whole problem and clarifying the principles of street-lighting will be available.

* One lux is roughly equivalent to 1/10th foot-candle.



The Work of the Committee on Illumination operating under the Department of Scientific and Industrial Research

It is announced that the next meeting of the Illuminating Engineering Society, to be held on June 1st, will be devoted to a summary of the work of the above committee. The discussion is to be opened by a paper by Mr. John W. T. Walsh, who as a member of this committee, and as the representative of the National Physical Laboratory, has been directly interested in the initiation of many of the researches described. This issue goes to press before the date of the meeting, but we shall give a full account of the proceedings shortly. Meantime we have no doubt that the paper will prove a revelation to many people of the large amount of useful research now going on; in this case, as in the case of the recent discussion of reports issued by the B.E.S.A. committee, the meeting should serve a useful purpose in stimulating interest in research on illumination, and in helping to make the work already undertaken widely known.

Street Lighting Tests in Leicester

We have often pointed out the desirability of actual tests of conditions of street illumination being made by the local authorities concerned, especially when new installations are contemplated. In deciding such matters all the various factors—general appearance of fittings, elimination of glare, uniformity of illumination between posts, candlepower and consumption of gas and electricity, etc.—have to be weighed, and it is often a great advantage to be able to study these factors with the lamps actually in position. We have received from Mr. Wilkie, the Public Lighting Superintendent in the City of Leicester, some records of tests recently conducted on gas and electric lamps, accompanied by curves showing the distribution of illumination in each case. In these experiments special attention was evidently devoted to the problem of maintaining as high an illumination as possible mid-way between lamps. Leicester is an example of a city where both gas and electricity are widely used for public lighting and where the conditions are favourable to systematic tests of the possibilities of both illuminants.

The Photoradio Transmission of Pictures

The process of wireless transmission of pictures, now being demonstrated by Marconi's Wireless Telegraph Co., is a step of considerable interest to the illuminating engineer, as it is based on the use of the photo-electric cell and is essentially a novel application of light. The transmitting apparatus uses a revolving glass cylinder on which a film photographed from the picture or writing to be reproduced is stretched. Light from the filament of a gasfilled lamp, concentrated by a reflector, is received by a travelling prism, and thereby directed radially outwards through the film, and finally focussed on a photo-electric cell. The glass cylinder slowly revolves and the prism travels to and fro. Each stroke of the prism corresponds with a line across the picture. As the cylinder revolves another line is traced. The fluctuations in light caused by the ray passing through dark and light portions of the film excite corresponding changes of current in the cell, which are amplified and "split" by a special circuit containing a condenser. Thus wireless impulses corresponding with gradations in tone of the picture can be generated. On the other side of the Atlantic their reception operates a pen travelling on paper stretched on a revolving disc, motions of both pen and paper being in exact synchronism with the motions of prism and drum at the transmitting end. The wireless impulses result in a series of dotted lines, and thus the complete picture is gradually built up. The recent wireless transmission of a cheque in this way occupied about twenty minutes. More or less complex pictures may require a few hours. But without the aid of this system of transmission days would be necessary. It is expected, therefore, that the process will prove of special value to newspapers and topical picture agencies, where time of transmission is all-important.

Comparisons between Lighted and Unlighted Highways

Under the above title Mr. F. C. Taylor contributes to the *Electrical World* a series of photographs illustrating the general effect of beams, on lighted and unlighted thoroughfares respectively, from a number of cars equipped with headlights approved by the New York State legislation. The photographs were taken by a camera mounted outside the car but adjacent to the window at the left of the driver. It is shown how in some cases pedestrians stationed on the side of the unlighted road 50 feet ahead of the camera were invisible, whilst in others cars parked at the side of the road (without lights) 80 feet away could not be seen. On roads provided with public lighting, however, the various objects were revealed in the photographs and were visible in every case.

Data obtained by the Bureau of Standards show that the distances at which cars fitted with standard brakes can pull up are as follows: at 25 m.p.h., 78·2 ft.; at 30 m.p.h., 112·1 ft.; at 35 m.p.h., 153ft.; at 40 m.p.h., 200 ft. It is deduced that on the unlighted thoroughfare pedestrians 112 feet away would not have been seen in time for the driver to pull up if the car was moving at 30 m.p.h. On the other hand, on a well-lighted road, objects over 200 feet away could be seen.

The lesson conveyed by these tests is that the provision of headlights alone, even of approved type, will not always enable drivers to see pedestrians or cars ahead in time to pull up when travelling at high speed. Hence adequate public lighting is necessary not only in the interests of safety but also to enable thoroughfares to be efficiently used. Proper lighting is therefore a good investment, as it increases considerably the possible speed of traffic and the capacity of the road.

Accidents Attributed to Bad Lighting

Instances of street accidents attributed to unsatisfactory public lighting are by no means infrequent and one can recall quite a number of coroners' inquests at which reference to this matter has been made. An instance is afforded by the inquest at the North Middlesex Hospital on Donald Wade, a member of the North London Harriers, who died from injuries received when knocked down by a car. The coroner exonerated the driver from blame, but complaint of bad lighting in the New Cambridge Road, Edmonton, where the accident occurred, was made.

Illuminating Engineering Society (U.S.A.)

Forthcoming Twentieth Convention

The twentieth Annual Convention of the Illuminating Engineering Society will be held at Spring Lake, New Jersey, from September 7th to 10th, inclusive, with headquarters at the Essex and Sussex Hotel. This well-appointed hotel is ideally located directly on the ocean front, a short trip from New York and Philadelphia.

A comprehensive papers programme is being prepared, with special features showing the developments in specific fields which have taken place during the twenty years of existence of the Society. Special and unique features are also being planned for the entertainment programme, and it is confidently expected that the 1926 Convention will prove to be a most successful one.

The Illuminating Engineering Society in Germany.

Several papers recently read before the Illuminating Engineering Society in Germany, which have now appeared in *Licht und Lampe*, deserve study. Amongst these may be mentioned Herr W. Wissman's review of the present position in electric street lighting and the communication by Herr W. Licht entitled "A Hundred Years of Gaslighting in Berlin." We also notice that on April 15th the Society met, by invitation, at the "Osram Lichthaus," when papers were read by Dr. L. Bloch and Herr L. Schneider dealing with Light and Colour, and a further paper by Dr. F. Skaupy discussed the ultra-violet radiation of the tungsten arc. In arranging occasional meetings at the Osram Lichthaus the Illuminating Engineering Society is following the practice of our Society, which on several recent occasions has enjoyed the hospitality of the E.L.M.A. Lighting Service Bureau. As recently remarked the facilities for demonstrations furnished by the Bureau have been very helpful, notably on the occasion of the paper on stage lighting recently read by Mr. H. Lester Groom.

Inside Frosting for Electric Lamps

It will be recalled that some time ago we drew attention to the "inside frosting of lamp-bulbs" recently introduced in the United States. The primary advantage claimed is that the diffusing coating is not exposed to the outside dust, and the exterior of the bulb, being polished, can be easily kept clean. It appears, however, that the low absorption of light claimed for this method is due largely to the way in which the frosting is carried out. Micro-photographs show that the frosting consists of a relatively small number of circular depressions, which are less liable to cause the development of cracks than irregular gashes. According to the data presented in American journals, the loss of light, after the lamp has been in use for some time, with inside frosting is only 1 to 5 per cent., as compared with 10 to 20 per cent. for outside frosting. When unlighted the bulb appears to be a light grey, with the property of blending readily with the background. The colour of the background is diffused within the bulb itself, giving it a faint corresponding tint. It is, therefore, believed that the appearance of the unlighted lamp during the daytime will be considerably improved.

Novel Forms of Portable Lamps

Attention was recently drawn to various ingenious lighting devices shown at the Exhibition of Decorative Arts in Paris. Another illustration of this tendency towards originality in design is to be found in certain portable lamps evolved in France. These depart entirely from conventional lines. The standard consists of a moulded quaint figure, which can be designed to accord with the general style of the room. The source of light is mounted in some object carried by this figure. For instance, a bouquet carried by a charming figure of a girl in 18th-century costume contains a concealed lamp; or the lamp may be introduced into a miniature lantern carried by a rustic, or a pierrot's drum. The light is diffused by the material in which the bulb is enclosed, and the position of the lamp can be contrived to good downward illumination; thus the devices answer the primary purpose of a portable lamp sufficiently well, and any sacrifice in efficiency is compensated for by artistic effect and originality in design.

A Tax on Lighting Fittings

For some time there has been in Germany a curious form of tax, from which we in this country are fortunately free: the "Luxussteuer" on certain forms of lighting fittings. Under the regulations hitherto applying the tax applied, irrespective of the position of lights, to fittings used in conjunction with precious stones and metals, or of base metals plated with platinum, gold or silver. In addition all lighting fittings were subject to tax, irrespective of the material, when the number installed exceeded ten. The tax apparently also applied to all standard portable lamps and candelabra of ceranic materials.

According to *Light und Lampe* this tax was removed on April 1st, so far as lighting appliances were concerned.

The Principles of Illumination

The active interest that is being taken in the subject of illumination in France is again illustrated in a contribution "Les principes de l'éclairagisme," contributed by M. S. de Mesnil to *l'Electricien*. After recalling some of the steps that have been taken in other countries to promote public appreciation of the benefits of good lighting the author mentions the formation in France of the "Société pour le perfectionnement de l'éclairage," to which attention has already been drawn in these columns. M. Mesnil emphasizes the importance of judicious methods of lighting in order to facilitate accurate and comfortable vision, attain maximum efficiency and eliminate industrial and street accidents. He also points out the variety of systems of lighting now available to the public—direct, indirect and semi-indirect—and remarks on the need for knowledge in making a selection. Hence the necessity for a new science, devoted to the utilization of light.

SPECIAL SECTION

The Optical Convention

(Held at the Imperial College of Science and Technology, South Kensington, during April 12th-17th, 1926)

Introduction

IN our last issue a brief reference was made to the proceedings at the Optical Convention.* In this number we are giving a more detailed account, especially of the papers of chief interest to readers.

It may be recalled that the convention was opened on April 12th by the Prime Minister, Mr. Stanley Baldwin, who emphasized the important part played by optical munitions during the war and by optical instruments as "avenues to knowledge." Thus the telescope has given us such knowledge as we possess of distant worlds, and the microscope has made possible the study of minute objects and rendered incalculable services to medicine and hygiene, besides having contributed to many discoveries in metallurgical work.

Mr. Baldwin afterwards made a tour of the exhibition, where a very comprehensive series of optical instruments of all kinds was on view. (A description of some of the chief exhibits will be found on pp.137-138.) Besides the commercial exhibits of instruments, etc., there were also interesting demonstrations in the Research Section, including that arranged by the Illuminating Engineering Society, to which reference was made in our April issue.

Before proceeding to give an account of the papers and exhibits, a few words may be said about the various amusing illusions and entertainments.

Illusions and Entertainments.

There were many simple experiments and illusions, based on the use of mirrors. One of the most popular of these was "The Intangible Lady," whose head and shoulders appeared floating in mid-air, in quite a lifelike way. The same device, the formation of an image of a concealed object at the focus of a concave mirror, was used in another equally popular device, "The Vanishing Banknote." A cluster of banknotes, apparently placed in a wooden case within easy reach, could not be grasped in the hand, being really merely the image of the illuminated real article, concealed below the mirror. These and other illustrations of the same principle depended for their success on effective illumination, the concealed object being strongly lighted and seen against a dark background. "The Death Ray" exhibit enabled a visitor by alternately switching on and off a light to see first his own face and then a skull, the former being the reflection when his face was illuminated, and the latter an effect conveyed by lights transmitted from behind the mirror, which was masked by the very much brighter image in the mirror. Other mirror exhibits showed the formation of a double image of the observer ("Dual Personality") and various effects of distortion. A most beautiful and instructive experiment was the "Levitated Bowl"—a bowl electro-magnetically maintained in position without visible support, out of which streams of water flowed continually. It is possible that some visitors overlooked the beautiful display of effects of Ultra-Violet Light in an adjacent darkened room. Here many examples of fluorescence under the action of radiation from a quartz tube lamp, such as the glow of pearls and precious stones, pictures executed in luminous paint, were seen.

Much interest was shown in the ingenious "Fairies Theatre." The optical basis, devised by Dr. R. S. Clay, was simple, an image being formed of the figures of students of the Royal Academy of Dramatic Arts, who gave performances organized by Mr. Kenneth Barnes (the Director) and M. Komisarjevsky. Two performances, "The Vagabonds" and the "Commedia dell' Arte," were given. The view of the motions of figures, apparently less than six inches high, was a curious spectacle. It is, we believe, the first occasion on which such an effect has been demonstrated to a relatively large audience, and no doubt the effect (the view was not equally good at all angles) could be developed further by experiment.

Another series of entertainments, "The Invisible Man," "The Lady Who Lost Her Head," "The Principles of Levitation," etc., arranged with the assistance of Captain Clive Maskelyne and Mr. Jasper Maskelyne, were essentially conjuring tricks that depended on the deception of vision. To the student of illumination there was much of interest in the manner in which the tricks depended on contrast-effect and, in some instances, the cunning use of a certain amount of glare from lights in the foreground designed to prevent the "works" being evident. In these and some of the foregoing entertainments it might have been instructive for the public, as suggested in our last issue, if more attempt had been made to take the audience into confidence and explain how the marvel was done. Such entertainments, less elaborate and effective but based on similar principles, were used to illustrate the marvels of science in the early days of the magic lantern.

Another class of entertainments was the series of exhibits showing progress in the projection of light. To this class belong the Electric Kaleidoscope of Mr. Theodore Brown and the Kaleidoscope Projection, devised by Dr. R. S. Clay. The Lantern Projection in Natural Colours by the Ives Projection Kromskope and the Projection of Figures in the Solid (in which visitors were furnished with red and green coloured screens through which to view the projected image of a dancer, thus obtaining a stereoscopic effect) were instructive. But one of the most effective entertainments in this class was doubtless that of "Talking Films," Sir William Bragg delivering a short lecture on the structure of atoms, aided by models, and Sir Richard Paget demonstrated artificial speech. The latter demonstration was especially well suited to show the possibilities of phono-films. In both cases the synchronism of the actions and speech of the lecturer made the event a lifelike performance, and in the case of Sir Richard Paget's lecture the reproduction of the weird noises made by the artificial speech apparatus heightened the effect of reality.

* *Illuminating Engineer*, April, 1926, p. 98.

Papers Read at the Optical Convention

Introduction

A very comprehensive series of papers, over one hundred in number, was read at the Convention, and at the request of numerous readers we are giving a summary of those of chief interest. A considerable number dealt with some aspect of physical or physiological optics of direct interest to illuminating engineers. A paper, read in abstract by Mr. L. Gaster, entitled "Illuminating Engineering in Relation to Optics," aptly illustrated the many points of common interest to illuminating engineers and students of optics. Other papers may be divided broadly into groups dealing with Photometry and Standards of Light, Projection Apparatus and the Photometry of Projected Beams, Colour, Spectrometers and other Optical Apparatus, Relations between Illumination and Acuteness of Vision, etc., in addition to many of a purely optical nature dealing with problems in Lens Design, Navigational and Levelling Instruments, Historical Data, etc.

We propose to deal briefly with each of these groups in turn.

Photometry and Standards of Light.

The Use of Photo-Electric Cells for Precision Photometry of Electric Lamps, by T. H. Harrison.—In the introduction to his paper Mr. Harrison recalled that photo-electric cells have been used for stellar photometry and for measuring small differential changes in intensity for several years. But it is only recently that the possibility of using them for ordinary photometric comparisons of electric lamps has been studied. Dr. Norman Campbell, of the G.E.C. Research Laboratories, Wembley, was the first to commence investigations in this field, and communicated some of his results to the National Physical Laboratory, to whom he presented several specimens of the vacuum cells used.

The difficulties arising in the use of photo-electric cells are well recognized: (*a*) It is at present impossible to make a batch of photo-electric cells in which the photo-electric current is accurately proportional to the intensity of the exciting light; (*b*) no two cells of the same metal have identical sensitivity curves, except by chance; (*c*) no cell is exempt from photo-electric fatigue and recovery of some sort or other, whether occasioned by heat or light; (*d*) sensitivity curves of cells probably change slightly with time.

These facts impose certain limitations on methods of working. Thus it is convenient to ensure the flux of light into a cell being constant, e.g., by altering the distance of one of the lamps on the photometric bench, so that the relation between illumination and response of the cell is not material. Further comparisons must be made between lamps run at approximately the same colour, and there must be a clear distinction between "sensitivity" and "accuracy."

In the apparatus described one lamp is placed at the centre of a cube (preferably not less than four feet in diameter), at the bottom of which are two cells, one sodium and the other rubidium, an inch apart. Between the lamp and the cells is the usual screen. In making measurements a rubidium cell is placed in a box provided with a sliding wedge and filter-case at the end of a 10-ft. photometric bench. One of the cells at the bottom of the tube is removed, and the other provides a balancing current for the cell illuminated by the lamp on the bench. The arrangement thus works on the Wheatstone bridge principle.

Data presented relating to colour-matching results show an agreement between visual and photo-electric tests varying from 0·4 to 3·96 per cent. for different cells. The effect of colour differences can be much reduced by placing a Wratten No. 9 filter in front of a rubidium cell, which renders the sensitivity curve very close to that of the eye. In these circumstances a 1 per cent. error in voltage for colour-match will lead to 0·1 per cent. error in intensity measurement. Fatigue effects have to be guarded against. Thus a rise in temperature to over 50° C., with the cells placed at the top of the box cube, reduced the sensitivity to only one-tenth of its former value and altered the balance point by several per cent. Slow drifts are evident. By using a large cube and placing the cells at the bottom instead of the top the heat-effect is much diminished.

On the whole, the author deduces that, with care, intensity tests can be carried out with an accuracy of 0·1 per cent., which suffices for all ordinary work. It is suggested that eventually, although the ultimate standards of illumination must be set up on the basis of visual methods, sub-standards and comparison lamps may be calibrated more accurately by photo-electric than by visual methods.

Variations in Tungsten Filament Vacuum Lamps; a Study in Photo-Electric Photometry, by N. R. Campbell and M. K. Freeth.—This paper, communicated by the Research Laboratories of the General Electric Co., Wembley, again illustrates the utility of photo-electric photometry in studying the variation of tungsten filament lamps. The photo-electric methods used have already been described in the *Journal of Scientific Instruments*. The chief conclusions are set out as follows:—

(1) No consistent difference is found in the luminous efficiency of drawn tungsten wire prepared by different methods; but single crystal wire prepared by the Pintsch process has an efficiency of about 1 per cent. greater than that of drawn wire. This difference is not due merely to the greater size of the crystals.

(2) Different lengths of the same wire differ by several parts in one thousand in the currents required to heat them to the same temperature. These differences are due to variations in diameter, but also partly to variations in the shape of the cross-section.

(3) Similar differences are found in efficiency, which may be due to lack of uniformity of a single filament along its length; but

(4) Glass bulbs similarly differ by at least 1 per cent. in their absorption, and the apparent variation in efficiency may be due to this cause.

(5) The temperature coefficient of resistance depends on the mechanical treatment of the wire rather than on such impurities as occur in practice.

(6) If great consistency is required, it is better to rate lamps by current rather than by voltage.

Incandescent Lamps as Sub-standards.—Under this heading two papers may be noted. That by Mr. W. Barnett, of the National Physical Laboratory, contains a review of progress in the design of electric incandescent lamps for sub-standards since the original carbon filaments described by Dr. Fleming in 1902. In 1909 the National Physical Laboratory, with the co-operation of the Omega Lamp Co., prepared standard lamps with metal filaments for use on 100 volts. With the advent of the drawn tungsten-wire filament the design was modified by the Osram Lamp Works, so that lamps could be burned base down. In 1922, as a result of international consideration, a specific consumption of 1·5 watts per candle for such tungsten filament, giving a match with the light from carbon-filament lamps, was adopted, and a series of lamps of graded efficiency was evolved for use on the "cascade" principle with a view to facilitating comparisons with lamps of normal efficiency. No considerable increase in efficiency beyond that specified above for sub-standard has since been advocated.

The design of metal-filament standard lamps presented special problems. The much longer filament necessitates multiple supports, the cooling effect of which may vary slightly from day to day. Such variations have been carefully studied and special attention has been devoted in the preparation of lamps to the maintenance of the correct degree of steady tension and the elimination of any uncertainties due to oxidation at the points of support. Consideration should also be paid

to the direction selected in which light is measured, so as to avoid possible shadows and striations caused by the bulb.

Exchanges of standard incandescent lamps between the chief laboratories in various countries were made in 1906, 1908, 1912-13, and again in 1924-26, and the data presented for these variation-years shows a steady advance in the accuracy with which results can be repeated, which, on the last occasion, reached a high degree of precision. Reference is made to the important decision taken in 1909, when the "international candle" now in use was agreed upon by France, Great Britain and the United States.

Gasfilled tungsten lamps as standards are still in the experimental stage, and although considerable progress has been made they have not yet attained the same consistency as vacuum lamps.

A further communication from Messrs. B. P. Dudding and G. T. Winch, of the Research Laboratories of the General Electric Co. Ltd., deals with "Incandescent Electric Gasfilled Standards." This also contains a preliminary review of vacuum standard lamps, operating at 2,300 K. and working at 1·5 watts per candle. The chief problems, already dealt with above, were (1) the mounting of filaments in one plane, (2) the maintenance of constancy at contacts, and (3) the avoidance of uneven illumination. Of these (2) proved the most difficult. Dealing with gasfilled standard lamps, it is remarked that originally sufficient stability of the coiled form of filament was only found possible in the case of the larger sizes of lamps. It was also found that changes in the characteristics of the lamp could only be eliminated by means of spot-welded contacts. Considerable progress has been made, and the difficulty in making suitable small lamps has been largely overcome, but their transport requires considerable care.

Colour Corrections for Integrating Photometers.—The paper by Mr. R. C. Fox on the above subject points out that in the integrating sphere any colouration of light due to the paint used is accentuated by repeated reflection. What is wanted is a dead-white paint of 100 per cent. reflecting power, not varying with age. Various materials have been suggested (magnesium carbonate, zinc oxide, barium sulphate, etc.), but none of these is absolutely non-selective. Barium sulphate is perhaps best in this respect, but is difficult to apply. Magnesium oxide turned yellowish within 24 hours, after which it remained sensibly constant.

The author experimented with the paint recommended by the Bureau of Standards based on the use of zinc oxide, credited with 94 per cent. reflecting power. The demonstration of the effect of the interior coating involves the comparison of identical lamps, run at the same voltage, one inside and one outside the sphere. It is shown that the departure from perfect whiteness materially affects a curve connecting voltage and candle-power of an electric incandescent lamp, owing to the effect of the change in the colour of light emitted. The errors can be conveniently eliminated by the use of a suitable glass, slightly tinted blue, in front of the observation window.

Portable Photometers.

Some Notes on Portable Illumination-Photometers, by A. K. Taylor.—The paper presented by Mr. A. K. Taylor (National Physical Laboratory) dealt with some points arising out of the B.E.S.A. Specification for Portable Photometers, already reproduced in this journal.* So far as the author is aware, this is the only photometer specification in existence. Dealing with the various classes of instruments the author considers that, on the whole, those in which the comparison surface is viewed through an aperture in the test-surface are to be preferred. It is also desirable that the instrument should work on the inverse square law, in spite of the drawback that the sensitivity is greatest at the lower end of the scale and least at the maximum reading. It should generally be possible to provide a range ratio of 20:1 without reducing screens; with the aid of filters this can be extended from 2,000 to 0·01 foot-candles, but owing to the difficulty of obtaining a really neutral filter the use of very high ratios should be avoided.

The test-surface is one of the main causes of error, as there is no substance which acts as a perfect diffuser. In the original paper an instructive series of diagrams showed the departure from perfect diffusion with different angles of incidence and various points of view. The substances tested included white blotting-paper, white matt pot-opal glass, magnesium carbonate and oxide, white matt celluloid and Bristol board, white matt paint, etc. Of all these materials white pot-opal glass gives the best results. By working at the most favourable angle of view (30°) the error can be reduced within 2-3 per cent. But errors as great as 10-15 per cent. may occur if the direction of view is not properly chosen with respect to the direction of the light. In actual use it is not always possible to determine the best angle of view, especially when the illumination is derived from a number of sources. The author has accordingly suggested the adoption of another device instead of the usual plane surface, namely, a small internally whitened sphere. The brightness of the inner surface of such a sphere, which may be 4-6 inches in diameter, would be strictly proportional to the direction of the incident light. Its interior can be viewed through an aperture terminating the sighting tube of the photometer.

Illumination photometers in which the comparison surface is viewed through an aperture in the test-surface may also be used to determine brightness, according to the relation $B=\rho E/\pi=k\,R\rho/\pi$ (where B indicates brightness in candles per square foot, E the illumination in foot-candles, R the instrument reading, k a constant (often unity) and ρ the coefficient of reflection of the test-surface used). If ρ is not known it may be measured as follows: Let S be a source of known candle-power fixed at a distance d from the test-surface T. A bench photometer is set up and the total candle-power of T measured, the angle between the line of the bench and the direction of incidence of the light striking T being ϕ, the angle of view for which the reflection factor changes least with the angle of incidence. (Care must be taken that the distance of the photometer from T is not so small that the inverse square law does not hold.) The illumination E on T is S/d^2. If A is the area of the test-surface and I its candle-power as measured by the photometer, then the brightness of T at the angle ϕ is $B=I/A\cos\phi$. Hence $\rho=\pi\,B/E=\pi\,Id^2/SA\cos\phi$.

For reducing screens the best device is the double glass wedge, which can be adjusted to a round figure of transmission; alternatively a plate of neutral glass, optically worked to the thickness required, may be used.

In the Standard Specification the use of a voltmeter is prescribed in preference to an ammeter, because the change in candle-power produced by a given percentage error in reading the instrument is only 5-7 per cent. for the voltmeter as compared with 10 per cent. or more with the ammeter. Even so the voltmeter must be read to within 0·15-0·2 per cent. in order that the error in illumination may not exceed 1 per cent. This, it is suggested, is a figure beyond the compass of any commercial instrument.

The ageing effect of small lamps used in illumination photometers is often important. The average error resulting from observation, instrument scale readings, voltage or current adjustment, incorrect angle of view, ageing of comparison lamps, incorrect angle of test-card, stray light, etc., is difficult to estimate. But there is no doubt that the errors due to incorrect voltage or current adjustment and to ageing could be reduced—the latter by the use of suitable comparison lamps, with a longer filament taking preferably two to three volts, and the former by using a bridge method of measuring the current. The method proposed by the author consists of a bridge circuit with the photometer lamp in one of its arms. A low-resistance galvanometer capable of giving full scale deflection for about 5 milliamperes is used. With this the current could be easily set to within 1/40 milliampere.

* *Illuminating Engineer*, November, 1925, p. 298.

In conclusion, the author remarks that an instrument working on the inverse square principle, with a Lummer-Brodhun contrast type of head, efficient and permanent screening, no reflection from lamp-bulb, a lamp taking, say, 3 volts at $\frac{1}{4}$ amp., and a bridge method of control, should be capable of repeating reading to within 2 per cent. Further, if an aperture in a whitened sphere be used as a test-card, then illumination could be measured with an overall error of less than 5 per cent.

The Photometry of Projection Apparatus and Projected Beams.—A paper by Mr. J. W. T. Walsh, mainly mathematical in treatment, contained an outline of methods of computing the minimum distance at which photometric measurements may be made for various types of projection apparatus, designed to give a beam of minimum divergence. Formulæ were derived for the parabolic mirror and the lighthouse lens. Such measurements present no difficulties, provided the distance is sufficiently great to enable the inverse square law to be applied. For the parabolic mirror the following rule is sufficiently exact for practical purposes, so long as the source of light is small:—

$$\frac{\text{Minimum distance for measurement}}{\text{Focal length of projector}} = \frac{\text{Diameter of projector}}{\text{Diameter of Source.}}$$

As soon as the distribution of light in directions inclined to the axis is considered the problem becomes much more complicated. The author also derives formulæ for use in these circumstances. Theoretically accurate measurements can only be made over a limited range of angles, which is much less than the total divergence of the beam. For practical purposes, however, measurements over the major part of a beam may often be made without appreciable error owing to departure from theoretical distribution of the flux.

Lieut.-Col. Silvester Evans also discussed the photometry of beams of small divergence. As an indication of distance required, he mentioned that for a 170-amp. arc in a 42-cm. mirror with 90-cm. aperture a distance of 250-300 metres is desirable. In this case the average candle-power from the source is about 75,000, the dispersion 3·5°, and the "effective candle-power" 7×10^7 candles.

In order to enable measurements to be made in a relatively small space, he suggests the use of a mirror placed 10-15 metres away on the axis of the projector. A diffusing test-surface is placed at the focus of this secondary mirror so as to receive all light reflected by it. This diffusing test-surface then becomes a secondary source of light, and its intensity can be measured by the use of a photometric bench in the usual way. Owing to the intense heat, the nature of this surface requires consideration. In practice it was obtained by coating a water-cooled cylindrical pot with zinc oxide. The whole apparatus can be conveniently calibrated with a "Pointolite" lamp.

Ships' Navigation Lanterns.

A paper entitled "The Performance and Design of the Optical System of Ships' Navigation Lanterns" was read by Dr. E. H. Rayner, of the National Physical Laboratory. The technical performance of navigation lights used in the Mercantile Marine was considered by a Committee, on which the National Physical Laboratory was represented, appointed by the Board of Trade in 1920. These investigations showed that 1·6 candle-power was necessary for visibility at a distance of 2 miles. Whilst electric lamps are used on steamers, oil lamps are mainly used on other vessels, and yield, under the best conditions, a candle-power of 16. A value of 12 candles in the broadside direction is a good value to assume. To obtain colouration for the starboard light glass tinted by copper is used, giving green; for the red port light the colour is "flashed" as a very thin layer. To obtain adequate green colour an absorption of 85-90 per cent. of the incident light is inevitable. Screens transmitting not less than 10 per cent. and not more than 15 per cent. are officially specified. It would be practicable to obtain a satisfactory red glass with a higher transmission, but in practice it is considered inadvisable to have one light brighter than the other.

Allowance must be made for a lower candle-power in other than the broadside direction, and as the candle-power of the source is 12 the lens is required to give the effect of 24 candles. The lens factor is accordingly 2·0, which must be attained with angles of roll of 5° up or down. Diagrams are included in the original paper showing the desirable distribution of light at different angles. To ensure toughness and durability of the glass a considerable proportion of lead in the glass is desirable. The amount specified is 25 per cent., giving a density of 2·9 and a refractive index of 1·542.

Photometric tests were made at a distance of five metres, using a Lummer-Brodhun photometer and an electric comparison lamp. In the original paper the design of the lens system is described in detail. This involves a central cylindrical lens-element and a series of prism-elements on either side, the design being symmetrical, so that there is no danger of results being affected by the lens being inadvertently mounted upside down.

For the masthead light, which must be visible at five miles, 10 candles were found to be necessary. A 12-candle-power lamp, unscreened, would thus just suffice to give this range. But as the light is less accessible, and atmospheric absorption is here more important, the same lens-factor, 2·0, was adopted. For this light, also, a special lens-design was worked out.

For the starboard light there appeared to be only one glass commercially available, the glass covered by copper, giving "signal-green." The red glass is also copper-coloured, but is "flashed" as a thin film. The Board of Trade eventually requested the National Physical Laboratory to prepare 250 sets of standard glasses, each set consisting of four glasses, two red ones of 10 and 15 per cent. transmission respectively, and two green ones of the same values. It was decided that a margin up to 5 per cent. transmission percentage might be allowed in glasses. Much of the green glass was so homogeneous that it was sufficient to bring all glasses to a specified thickness. Red glasses had to be obtained by selecting suitable areas from sheets.

Illuminating Engineering in Relation to Optics.

A paper on the above subject, by Mr. L. Gaster (Hon. Secretary of the Illuminating Engineering Society), emphasized the many problems of common interest to illuminating engineers and experts in optics. Such points as the illumination of the fields of microscopes, the "ultra" microscope operating with ultra-violet light, and the design of kinema projectors involved both illumination and optics. The percentage of the original light which reached the screen from a kinema projector was still extremely low; many interesting problems also arise in the illumination of scenes for film-production. Photography by artificial light was a new field opened out by illuminating engineering. Good photographs of lighting installations, taken entirely by the light provided by the units and showing the actual conditions at night, were now in common use.

Turning to problems connected with colour, Mr. Gaster referred to the progress made in "artificial daylight," and emphasized the part played by the latest forms of spectro-photometers in enabling the colour-values of different illuminants to be compared, and the fidelity with which daylight could be imitated artificially tested. Such tests were of great importance. In passing, Mr. Gaster referred to a recent development—the use of eyeglasses composed of "daylight" glass, which caused artificially illuminated objects to appear in natural colours, as seen by daylight. Mr. Gaster also referred to the effect of light of different colours on the eye. There was no adequate evidence available in support of the view that the habitual use of artificial light was responsible for deterioration in vision. At the same time the effect of light of different colours on vision deserved consideration. It was sometimes claimed that a source approaching closely to daylight in colour made the effort of accommodation less severe, and was less fatiguing.

Attention was drawn to recent work on special forms of glass; for example, those devised for the purpose of checking the passage of ultra-violet light and used by arc-welders and others, and those prepared to facilitate the passage of a section of the ultra-violet region, such as "Vitaglass." The whole question of the effect of the ultra-violet rays in sunlight on health had recently been attracting much attention. The quartz-tube mercury-vapour lamp was mentioned as an instance of valuable qualities, quite distinct from the original object of the inventor, being afterwards discovered. The original intention in using quartz was to enable a higher temperature and better luminous efficiency to be obtained. The powerful ultra-violet light was at first regarded as a drawback, as the lamp had to be enclosed within a dense glass outer globe for ordinary use. It was only later that the useful applications of these ultra-violet rays were discovered. To-day the great majority of these lamps are applied not for illumination, but for the sake of this special non-visible radiation.

In the latter part of the paper Mr. Gaster referred to fundamental problems of interest to opticians met with in illuminating engineering. He discussed in some detail the relation between intensity of illumination and ease and speed of work, summarizing the conclusions of the Home Office Departmental Committee on Lighting in Factories and Workshops, and referring to the investigations of the Committee on Illumination working under the Department for Scientific and Industrial Research. In all such problems the effect of light on the eye had to be considered, and the eyesight of operators taking part in special experiments should be tested. In some forms of fine work high acuteness of vision was very important; if an eye was incapable of focussing detail clearly, no amount of illumination would make good the defect. In some sections of the textile and hosiery trades magnifying glasses were essential, and their manufacture offered opportunities to the optical industry.

In conclusion, reference was made to the important part played by illumination photometers in enabling lighting requirements to be studied and tested, and it was pointed out that the design of accurate instruments of this type involved many interesting optical details.

Illumination and Acuteness of Vision.

The relation between illumination and acuteness of vision was dealt with in several papers, notably by Mr. R. J. Lythgoe and Dr. H. Hartridge. The tests were based on the observation of printed type, by two methods, (*a*) noting the number of mistakes, with prolonged observation, at a small angle, and (*b*) noting the number of mistakes with a brief period of observation, and a large angle. Both methods led to substantially the same results. The authors conclude that whilst 2-4 foot-candles are probably adequate for a variety of purposes, the results agree with those of Koenig in indicating that only half full acuity of the eye is achieved, and that for maximum visual acuity 100-200 foot-candles may be necessary.

The paper by Mr. Owen Aves entitled "The Relative Distribution of Refractive Defects and their Correction" contained a useful statistical survey. Amongst occupations which are most exacting to the eyes, sewing and clerical work are mentioned. High illumination is necessary in dealing with dark materials, and it is possible that colour of material plays a part in accentuating visual fatigue of some eyes, whilst striped material is particularly trying to eyes which have some measure of astigmatism. Clerks, accountants and stenographers are all liable to suffer from eye trouble, and eye-strain is intensified by the use of flimsy paper covered by more or less illegible handwriting. The important part played by illumination in relation to defects of vision is emphasized. Very high illumination, and even glare, may be desired by some people, because a bright object in the field of view leads to contraction of the pupil aperture, thus diminishing the effects of lens-aberrations. But evidently continuous contraction of the pupil by this means is liable to give rise to fatigue. The presence of glare leads to facial contortions, such as screwing up the eyes and frowning, besides being prejudicial to vision.

Several other papers dealt with vision, one of the most detailed being that by Mr. E. F. Fincham, on "The Mechanism of Accommodation."

Further information on conditions affecting the efficiency of the eye is to be found in the paper by Mr. L. C. Martin ("Some Visual Factors Affecting the Use of Optical Instruments"). The size of the field of view has been shown to have an important bearing on the precision of photometers. And it is also not without influence on the readings of other optical instruments. Mr. Martin accordingly suggests the desirability of the arrangements being such as to permit intelligent variation in the size of the field by operators.

Colour Problems and Colour Vision.

Colour Problems in the Woollen and Worsted Industries.—A paper on the above subject was read by Messrs. S. G. Barker and H. R. Hirst, of the British Research Association for the Woollen and Worsted Industries. Two problems of great importance to the industry are: (1) The fastness and durability of the colour to the influence of external conditions, and (2) the exact shade of the colour. External influences may be chemical, such as the effects of the alkalis, acids, oils, etc., and physical, such as humidity, temperature, light, and friction. Present methods of estimating physical effects are unsatisfactory. There is no standard source of daylight for making comparative tests. The limits of the solar spectrum are influenced by the seasons, the height of the sun above the horizon, the altitude, and by atmospheric conditions. Apart from visible light, the amount of ultra-violet radiation varies greatly. An artificial source of light is therefore sought which shall possess approximately the same energy distribution as summer sun at sea-level. Various suggestions have been made. H. P. Gage proposed that "average daylight" should be an average between blue-sky light, sunlight, and light given by a black body at 6,500-7,000°. This approximates to a north light. (Fading experiments show that north light fading is of the same quality as south light fading, but is not so rapid.) Photographic methods of studying energy spectra have been evolved. In the extreme red and violet regions of the spectrum visibility is low; yet radiation in these regions is most important for colour-fading. Hence lamps with filters, designed to imitate the visible spectrum of sunlight, do not answer for colour-fading tests. Certain forms of arc lamps seem among the most promising sources.

There are, however, many factors to be considered. The precise influence of temperature on fading has been little investigated. Humidity certainly plays an important part in the fading of dyes. Colours have been divided by Hermann into four categories, namely, those destroyed by (*a*) short wavelengths, (*b*) long wavelengths, (*c*) short and long wavelengths, and (*d*) by the longer ultra-violet wavelengths more readily than shorter wavelengths. There is a growing tendency to utilize the flaming arc lamp as a test-source for fading experiments. In the original paper a summary of results of exposing different colours to this source is compared with their relative fastness to sunlight. There is wide variation in the relative fading, and results obtained with the flaming arc and with sunlight are by no means consistent. It was, however, observed that five patterns of indigo-dyed calico, ranging from pale blue to full navy blue, behaved identically to sunlight and the electric arc. Yet another point to be studied in colour-fading tests is the angle at which light strikes the surface. In the experiments described the light struck the surfaces perpendicularly: in the case of sunlight the light falls at all angles, and the effect of this has yet to be investigated.

In the next section of the paper existing data on fading effect and photographic effect at different times of the year are compared. The fading effect naturally depends on the dye selected. From these tables the value in January appears to be about 10-25 per cent. of that in June. The adoption of a general system of classification of "fastness" is much to be desired. A method for easy and rapid exposure is necessary, so that mixtures can be readily tested, and a simple method of recording changes in hue is desirable. For purposes of colour-

matching the tintometer is probably still the most practical British system, and the Eastman colorimeter probably the most satisfactory single instrument. As regards the question of angle at which light is received, mentioned above, Dr. Martin and others have suggested 45°. The standardization of the colours and shades of all dyes on some definite system is absolutely vital to the dyer, and a method of testing the exact amount of fading under various conditions, so as to grade these dyes in order of fastness or fugitiveness, is equally important to the textile trade.

Colour in Relation to Printing.—Mr. William Gamble, in this paper, emphasizes the need for a standard system of describing coloured inks, and of apparatus for testing their permanency. Various systems of colour-nomenclature have been proposed, and colour-charts have been evolved. Classification presents great difficulties. It seems probable, however, that some degree of standardization could be effected if ink-makers would agree in:—

(1) The use of a standard daylight lamp.
(2) The illumination of test patches at a prescribed distance and a certain angle.
(3) The production of test patches by printing from a graduated tint block on selected paper.
(4) Viewing patches against colours to be matched from an aperture placed at a specified distance, all external illumination being avoided.
(5) The provision of standard viewing filters for placing over the aperture, for the purpose of finding out how nearly inks resemble theoretical colours.

Other Papers dealing with Colour.—Mr. A. J. Bull, in a contribution entitled "Some Peculiarities of Selection, Absorption, and their Effects in Technology" refers to the great variations met with in absorption spectra and the importance of relating colours to photographic effect.

Professor W. Peddie contributed a mathematical analysis of colour vision. After a discussion of recent work, the author remarked that more than a century had elapsed since Young postulated his theory, and nearly half that time since Helmholtz showed it to be not merely sufficient but unavoidable. New facts apparently unexplainable by the trichromatic theory were not really so, and the fundamental theory rested on a firm basis.

Professor Peddie also contributed an account of "A Colour Spectrometer." and Mr. J. Guild outlined some principles in "Spectrometer Design," as applied in the Watts Goniometric Spectrometer, built for the National Physical Laboratory.

Other items in the programme of papers dealing with colour included the demonstration of colour tests by the Lovibond Tintometer and the description of the "Theatre Mutochrome," by Mr. C. F. Smith.

Miscellaneous Papers.

Optical Glass.—The above papers only form a part of the large number presented, others being of a more purely optical character. An interesting account of "The Product of Glass for Optical Purposes" was presented by Messrs. W. H. S. Chance and W. M. Hampton. It was mentioned that from 1848 up to the outbreak of war Messrs Chance Bros. & Co. were the sole makers of optical glass in this country. In 1918 the output was four to five times the pre-war world demand. Now something like 112 different varieties were listed, including those for special press and aerial photographic lenses and a wide range of coloured glasses made to replace gelatine filters intended to isolate various parts of the spectrum. For "distant" signals on British railways special orange-coloured glass, to enable "home" from "distant" signals to be distinguished, had been developed. Other special varieties were the "Crookes" glass designed to check the passage of ultra-violet rays; "Calorex" glass, which transmitted light and absorbed heat, intended for the roofing of factories in tropical countries; "Antifade" glass, designed to protect the contents of airship sheds from prejudicial effects of ultra-violet rays; and the "Vitaglass," which was transparent to the portion of the spectrum most valuable in relation to health. Curves were also given for "Daylight" glass, showing the close imitation of average daylight which it permitted when used with gasfilled lamps.

Kinematograph Projectors.—A group of papers read on April 15th dealt with kinematograph projectors. Mr. R. J. Trump described two improved forms, (*a*) based on the use of a reflecting wheel in connection with a continuously moving film, instead of the customary intermittent shutter, and (*b*) with epicyclic gear used to drive a Maltese cross and intermittent sprocket, thus increasing the speed of operation. With the first arrangement there is a certain "shadowing" of the screen, but the effect is very different from the sharp cut-off of a shutter, resulting in less flicker and a more restful effect. The (*b*) arrangement also reduces the proportion of dark to light, the screen receiving illumination for two-thirds of the time, a gain of 33 per cent. In this case also there are advantages in regard to elimination of flicker.

The paper by Mr. W. Vintner discussed the International Standardization of Cinematograph Standards, and summarizes attempts to promote uniformity at various international gatherings. Mr. Theodore Brown, in a paper entitled "Phenomena of Light, Sight, and the Kinematograph," deals with methods of producing stereoscopic effects.

Uses of Selenium Cells.—The possibilities of selenium cells, and their application in talking films, etc., occupied several papers. Mr. E. Fournier d'Albe, in a paper entitled "Some New Applications of Selenium," remarks that the selenium cell stands out as the one giving the maximum of useful effect per unit of incident energy of radiation, though its most formidable rival, the photo-electric cell, has one important advantage—the instantaneous response and absence of "lag." Selenium cells operate very well for short period relay action. An exposure of 0·001 sec. was sufficient to give 20 micro-amperes in series with a galvanometer and a battery of 30 volts. This current suffices to work a sensitive relay of the Weston type. Selenium is capable of distinguishing changes in light-intensity of the order of 1/100 per cent., and has proved valuable in estimating the difference in the amount of light transmitted by different glasses. It also lends itself well to the construction of delicate line-elements for insertion in the eyepieces of spectroscopes. It is often assumed that the selenium is most sensitive to red. But, in fact, though it does react to red light, the action of violet and ultra-violet energy is much stronger. A curve plotted by the author shows almost equal response throughout the ultra-violet and most of the visible spectrum, the response declining in the red and gradually becoming zero in the infra-red region. A special example of its use is afforded by the mechanical counting of interference fringes, and it has also been applied in the study of star transits.

The Optical Analysis of Sound.—Its response to intermittent light is exemplified in the photophone and optophone experiments. Some of these form the subject of a second paper by Mr. Fournier d'Albe ("The Optical Analysis of Sound"). The apparatus here described is, in effect, an "acoustic spectroscope." An apparatus for this purpose should (*a*) be highly selective, and (*b*) respond within 1-40 sec., and cease responding within the same period after the stimulus is withdrawn. These requirements are almost incompatible, but the author describes methods by which the problem is fairly well solved. A series of compound resonators are used, each terminating in a reed of mica with a silvered cover-glass attached. Light is reflected from the cover-glasses, and the amplitude of the vibration thus registered is a measure of loudness. In this way sound can be analysed and photographic records of their constituents prepared. By means of the selenium cell, as in the optophone, these sound images can be reconverted and the original sound reproduced.

Yet another instructive paper in this group is that by Professor A. O. Rankine on "Optical Problems relating to 'Speaking Flms.'" In this it is explained that ordinary records of sound (the amplitude being shown by traverse ordinates), though useful for analysis,

cannot be applied to the talking film. What is needed is a film such that the density of each portion is proportional to the intensity of sound. The light from such films can be used to influence a sensitive cell, and this forms the basis of the talking films now used. Professor Rankine traced the various efforts that have been made to deal with this problem, among the earliest attempts being Ruhmer's experiments with a speaking arc in 1901. He discusses in turn modern methods, as illustrated in De Forest's "Phonofilms" and in the experiments of Bergland in Sweden. The optical problems are of considerable complexity, and the present stage has only been reached by very patient experiment.

The remaining papers dealt mainly with optical instruments, lens design, etc., one of the most interesting being Mr. Conrad Beck's account of recent advances in the manufacture and use of the microscope. Reference may also be made to two historical papers, the review by Dr. R. S. Clay of the historical instruments exhibited at the Convention, and a description, by Mr. R. S. Whipple, of an old catalogue of scientific instruments and curios collected by Queen Charlotte and King George III.

Exhibits at the Optical Convention

It is only possible to give a general idea of the very numerous exhibits in the various sections. They fell into three general groups: (1) Experimental and Research Section, (2) Historical Instruments, and (3) General Exhibits, the latter divided into many different sections. All sections of the optical industry were represented. The variety of optical instruments, including spectacles and eyeglasses, ophthalmic apparatus, microscopes, telescopes and binoculars, nautical and astronomical instruments, projection apparatus, etc., was remarkable, and in the case of many forms of apparatus their uses were illustrated by demonstrations and experiments. Optical apparatus being essentially based on an appeal to the eye lends itself well to demonstration, and many of the experiments included amongst the exhibits were quite as interesting as those in the "entertainments" section.

Experimental and Research Section.

The exhibit of the Illuminating Engineering Society was included in this section. The special photometer used during the war for the testing of candle-power for flares and star shells was shown and described, together with a model of the Holophane Lumeter, which was used in some of the earlier experiments of this special committee. There was also a comprehensive series of copies of *The Illuminating Engineer* containing records of researches and investigations undertaken by the Society, and various illuminated boxes (kindly loaned by the E.L.M.A. Lighting Service Bureau), illustrating principles in illumination. These boxes mostly operated on automatic time-switches so that contrasting light-effects were shown in succession. Thus, a plaster cast, seen against a dark background, was shown in turn illuminated from above and below and from the sides, the changes in expression in the man's face, owing to the varying shadows, being very striking. In another box a picture was seen illuminated successively by an ordinary incandescent lamp and a lamp with a "Daylight" bulb. A third exhibit showed how painted scenery can be entirely changed by switching on alternately red and green light. There was also a model show-window, in which the effect of exposed bare lamps and overhead lamps shielded by reflectors could be effectively demonstrated.

The National Physical Laboratory had a very complete display of optical apparatus, including special forms of microscopes, a polarization photometer, pyrometers and colorimeters, etc. Various methods of making accurate measurements by optical means, such as the testing of gauges, were demonstrated. There were other optical experiments arranged by the Technical Optics Department of the Imperial College of Science and Technology. The Northampton Institute had an exhibit of students' work and apparatus and microphotographs showing interesting features of the human eye.

The stand of the British Research Association for the Woollen and Worsted Industries was devoted mainly to a very interesting record of tests of "fading," undertaken by the flame arc and by daylight. A very wide range of coloured samples was presented. It was evident how, with coloured fabrics of certain shades, the methods gave similar results, whereas with other hues there were very distinct discrepancies. We understand that the fading effect of the quartz-tube mercury-vapour lamps is to be examined in a similar manner.

There were other useful exhibits in this section, amongst which may be mentioned a new method of photographic land-surveying, shown by Mr. J. W. Gordon, K.C., the "telephotometer" of Lieut-Col. Silvester Evans, which is designed to facilitate tests of the brightness of distant extensive surfaces, such as the sky, and an instrument for testing colour-vision, devised by Dr. R. A. Houston.

Historical Exhibits.

The historical instruments included a very numerous series of microscopes and telescopes dating back to the beginnings of the study of optics. Show-cases were loaned by the Science Museum, S. Kensington, and there were early types of apparatus contributed by the Royal Astronomical Society, The Royal College of Surgeons, King's College, Dr. R. S. Clay, Mr. Thomas W. Court and others. Professor F. J. Cheshire and Mr. B. K. Johnson arranged several of Newton's historical experiments. Such a representative collection can rarely have been assembled.

General Exhibits.

In the catalogue the general exhibit of optical instruments is arranged in about twenty groups, and it is obviously impossible to do more than mention a few salient points of interest. Generally speaking the display showed the great progress that has been made in the design of many forms of optical instruments since the outbreak of war in 1914.

Optical Glass, Lighthouse Lenses, etc.—Optical glass was dealt with in the display of Messrs. Chance Bros. & Co., one interesting feature being the series of coloured glasses imitating the range of gelatine filters commonly used for separating regions of the spectrum. The same firm exhibited types of lighthouse lenses and forms of automatic valve control (the essential principle being the difference in behaviour of clear and blackened bulbs, containing volatile liquid, when exposed to solar radiation, so that an acetylene flame can be automatically turned on at dusk and extinguished after sunrise). Automatic "flashers," serving both as a means of distinction and facilitating economy in the use of gas, were also on view. Searchlight reflectors and silvered-glass mirrors formed the chief feature in the exhibit of C. Parsons & Co., who have been associated with this form of work ever since the foundation of the Heaton works in 1889. A somewhat unusual type is the split parabola-ellipse reflector, specially designed for the navigation of channels, canals, etc., at night. This does just what is needed, i.e., lights up the buoys at the side of the channel, but at the same time leaves a dark centre so as not to dazzle the eyes of pilots of approaching vessels. (Thus we see in the navigation of rivers and canals problems similar to those involved in motor-headlights arising!)

Photometers.—Amongst photometers we may note the exhibit by Messrs. Wray (Optical Works) Ltd. of the latest model of the Holophane Lumeter, which has recently been fully described in this journal. There were some other special types. Thus Messrs. W. Watson & Sons showed the selenium density-meter, made to the designs of the British Photographic Research Association, and intended primarily for the examination of photographic negatives. The instrument can, however, be applied for other purposes. Two beams of light from the same electric light lamp, after being diffused by opal glass and conveyed by an optical system, fall in quick succession on a selenium cell. The objects whose den-

sity is to be measured are placed in the path of one beam and an adjustable and calibrated optical wedge in the path of the other. It is only necessary to adjust the wedge until the deflection of the galvanometer remains constant, and readings can be made quite quickly. Selenium again formed the basis of Dr. Fournier d'Albe's detector for infra-red, visible and ultra-violet spectroscopy. Various applications of this neat device were demonstrated. The Hilger "sector photometer" was designed for ultra-violet spectrophotometry, the relative lengths of exposure for two spectra side by side being adjusted by means of a variable sector-disc. The well-known Hilger-Nutting spectrophotometer, the use of which in tests of artificial daylight was recently described before the Illuminating Engineering Society, was also on view.

A novel form of photometer was also included in the Cambridge Scientific Instrument Co.'s exhibit. This takes advantage of the use of an analysing Nicol prism, by which the illumination of two sections of the field of view, derived respectively from a standard electric lamp and the illuminated surface tested, can be brought into equality. Readings are recorded on an angular scale. The instrument can be conveniently applied to testing the percentage of light transmitted by optical instruments.

Another item in the Cambridge Scientific Instrument Co.'s exhibit was the specially designed alkali photo-electric cells, and there were other forms of apparatus shown by this firm, such as the Callendar Sunshine Recorder, the photographic opthalmoscope and various measuring microscopes, microtomes, etc., of considerable interest.

Heat-resisting Glassware.—Generally speaking, lamps used for ordinary purposes of illumination did not figure largely amongst the exhibits. We should, however, mention the display of the South Metropolitan Gas Co., which showed a good range of "Metro" domestic gas-lighting appliances, including the standard domestic burner.

Special forms of glass for globes, shades and reflectors were, however, to be seen, notably the heat-resisting varieties shown by Chance Bros. & Co. and the display of Vitreosil glassware by the Thermal Syndicate Ltd. The recent use of Vitreosil material for the envelopes of mercury-vapour lamps is also interesting; the transparence to ultra-violet rays is accompanied by considerable diffusion of visible light, the latter probably a valuable quality in such cases.

Range-finders and sighting apparatus were exemplified in the exhibits of a number of firms, and the Aldis daylight signalling lamp, widely used during the war, is of special interest in view of the method adopted for ensuring correct position of filament with reference to the mirror. The same firm also exhibited a "daylight" floodlamp utilizing a large pane of Chance's daylight glass.

Colour Experiments and Demonstrations.—A good feature of the display was the pains taken by many exhibitors to show the working of their apparatus. Thus Messrs. Adam Hilger Ltd., in the dark-room occupied by their exhibit, showed spectrometers and spectrophotometers in action. Similarly in the Hilger "strain viewer," the use of polarized light to demonstrate the existence of strain in glass was beautifully shown, the stresses being indicated by coloured patterns on a mauve ground. In this way traces of a strain in an ordinary lamp-bulb can be clearly revealed. Messrs. Adam Hilger Ltd. had also on view the Mutochrome apparatus, for building up and projecting coloured patterns, a fascinating device which has been described before the Illuminating Engineering Society.

Other familiar apparatus included in the Colour Section included the Lovibond Tintometer and the Guild Colorimeter, the latter based on the trichromatic principle.

Various distinctive instruments exhibited by Messrs. Adam Hilger Ltd., included the Hilger Interferometers, the Acoustic Resonators and the new Photomeasuring Micrometer (which has been described by Dr. Blumbach, the well-known authority on Metrology, as the best instrument of its kind in the world). The acoustic resonators have the important property of responding to one vibration only, whereas ordinary types of resonators respond not only to the fundamental but to a whole series of overtones. As regards the Interferometers we understand that Mr. F. Twyman has recently been awarded the John Price Wetherill Medal of the Franklin Institute, for the invention of this class of instrument.

Many fine examples of special lenses, binoculars, telescopes and microscopes were shown at the exhibition. The display of microscopes for various purposes by Messrs. R. & J. Beck Ltd. would alone require a lengthy description to do justice to it. Devices for illuminating the field of the microscope, according to the nature of the object studied, are now the subject of much attention. Microscopes can be fitted with a projecting device throwing a magnified image on a screen, so that its features can be traced in pencil and diagrams prepared.

Lanterns and Projecting Apparatus.—Of equal interest was the display of modern lanterns and portable kinematographic apparatus in which great advances have been made during recent years. We were particularly struck by the automatic lanterns, in which a series of slides automatically comes into position at regular intervals, while in the episcope and similar apparatus the lecturer has now a new aid for the projection of diagrams and solid objets. A handy apparatus demonstrated was the Aldis "small object projector," whereby a magnified image of any object of small size, placed in the beam of light from a projector, is at once thrown upon the screen.

Sight-testing Apparatus.—Sight-testing apparatus, spectacles and eyeglasses, which perhaps come within the field of the largest section of the optical industry, naturally bulked largely in the Exhibition. One was glad to see that in a number of cases provision is now made for adequate artificial illumination of test-types, and that apparatus for testing the "light-sense," i.e., the percentage change in brightness which the eye is capable of detecting, is becoming more familiar. Various forms had also examples of portable hand-lamps for ophthalmic surgeons, capable of furnishing a uniform beam of light, the design of which was the subject of much study a few years ago.

Recording Apparatus.—Another class of apparatus to be mentioned is the variety of recording instruments, such as those shown by Negretti & Zambra for recording temperature, barometric pressure, etc., and by the Foster Instrument Co. for pyrometric work. In this section the exhibits of the Cambridge Scientific Instrument Co., comprising a variety of optical pyrometers, distance thermometers, etc., should be noted.

Surveying, Nautical and Astronomical Apparatus.—Surveying apparatus, theodolites, metroclines, etc., have now been carried to a high stage of refinement and the same applies to sextants and other nautical instruments. One interesting device in the latter section was the echo-sounding machine (Admiralty pattern)—a new acoustic method of sounding at sea which has been developed to replace the familiar lead and line. Apparatus is provided to produce a sound-wave under water, and the echo from the ocean-bed is received by a sensitive hydrophone. The recording gear measures the time elapsing between the sound impulse and the reception of the echo, and from this interval the depth can be deducted. Astronomical instruments included large-size telescopes, star-measuring machines and micrometers, chronographs, etc. There can be no doubt that the Exhibition, as a whole, revealed great progress by manufacturers in this country. It is to hoped that the aims of the organizers of the Convention will be realized, and the optical industry placed on a sound commercial basis, in keeping with the higher standard of technical skill revealed.

Illumination Research*

I—Introduction

THE development during the last 15 years of the technical side of illuminating engineering has brought about not only a constantly growing recognition of the importance of good lighting, but also the cheapening and accessibility of all forms of illuminants. The most efficient existing electric lamps, for instance, yield for a given cost approximately eight times the amount of light that was available from the original carbon lamps, and similar progress has been made in respect of gas lighting and arc lamps. In addition, light sources based on new principles, such as those using mercury vapour or neon, have become available on the commercial scale, and many new fittings and systems of lighting have been introduced, so that to-day there exist devices applicable to almost any situation that may arise. The attainment of successful illumination is contingent on the fulfilment of a series of conditions: at one end of this is the physical problem of furnishing light as economically and efficiently as possible; at the other end, the effect of the light utilized on the human eye, by which the suitability of any lighting installation is ultimately assessed. Hence, it is evident that not only the engineer and the physicist, but the opthalmologist, the physiologist and the psychologist must contribute to the solution of lighting problems. Further, in the lighting of buildings the conditions favourable to the convenient access of daylight must be studied—especially in view of the modern recognition of the close relation existing between sunlight and health—so that the co-operation of the architect also is required.

The first attempt in this country to secure this co-ordination was made in 1909 in the foundation of the Illuminating Engineering Society, by men of various interests who appreciated the importance of the subject and felt the need of a sustained study of its different aspects. Reports on the lighting of schools and libraries were issued by joint committees formed by the Society in 1913; and the Society, in conjunction with other leading engineering bodies, participated in the same year in the drafting of a standard specification for street-lighting.

The first official action dealing with illumination was taken in 1913, when, following some preliminary investigation carried out by the Factory Department of the Home Office, a Departmental Committee was appointed to inquire into the lighting of Factories and Workshops, the first Report of which (dealing with the general illumination of factory premises) was issued in 1915.

In 1917 a temporary Committee to deal with illumination was appointed by the Department of Scientific and Industrial Research, and occupied itself until its dissolution with various problems requiring immediate solution, notably inquiries into the possibility of maintaining home supplies of efficient illuminating glassware.

In 1921 the National Physical Laboratory was approached by H.M. Office of Works with a request for guidance as to the illumination desirable for general office work, and representatives of the Office of Works, the Post Office and other departments concerned were invited to become members of an Advisory Committee to report upon the matter. Meanwhile the Home Office Committee on Factory Lighting, which had been in abeyance during the war, had been reconstituted, and issued in 1921 and 1922 their Second and Third Reports, which emphasized the complexity of the problems involved in industrial lighting and the call for further research on the subject.

The need for an authoritative body to initiate and to undertake more comprehensive investigation into problems of illumination now became increasingly apparent, and, following a conference of the different Government Departments concerned, the present Committee was appointed in 1923 by the Department of Scientific and Industrial Research. The terms of reference of the Committee include investigations in connection with the lighting of buildings and allied problems, co-operation with the Medical Research Council in making arrangements for and supervising physical investigations needed in connection with physiological researches, and the supervision of approved investigations generally. The constitution of the Committee ensures the co-operation of physiologists, ophthalmologists and architects with illuminating engineers, and the Committee is kept in touch with bodies abroad which are also conducting researches on illumination.

Close relations have been established with the Committee on Physiology of Vision appointed by the Medical Research Council, and arrangements have been made for linking up the work of both Committees, thus co-ordinating the physiological investigations with those of a physical nature.

On the recommendation of the Committee, various Government Departments were consulted by the Department of Scientific and Industrial Research, and their views invited as to practical problems calling for investigation. From this source many suggestions were received, and whilst the Committee have been unable to include all of these in their immediate programme, certain of them have been selected as being of special importance and form the basis of several of the investigations now in progress.

Further problems calling for research have been submitted by the Sectional Illumination Standardization Committee of the British Engineering Standards Association and are now being investigated under the direction of the Committee at the National Physical Laboratory, whilst the collaboration of the Joint Industrial Council of the Printing Trades has been obtained in respect of an investigation into the lighting of fine processes.

Concurrently with these developments in England, similar action has been taken in several countries abroad. Illuminating Engineering Societies have existed for some years in the United States, Germany, Austria, and Japan, whilst in order to co-ordinate the activities in different countries steps have recently been taken to form an International Illumination Commission by broadening the scope of the original International Photometric Commission. Lastly, in the United States a Committee with constitution and functions very similar to those of the present Committee has been formed by the National Research Council and the American Illuminating Engineering Society.

The foregoing description of the Committee's origin, together with the programme of research which follows, is intended only to give a general idea of the scope of the investigations to be undertaken and of the extent to which the investigations of other extraneous bodies are linked with the Committee's activities. The results of investigations of general interest will be embodied in reports of which the following are at present in course of publication:—

(*a*) Definition and Explanation of the Terminology of Illumination and Vision;

(*b*) The Transmission Factor of Commercial Window Glasses (A. K. Taylor and C. J. W. Grieveson);

(*c*) Study of the Relation between Illumination and Efficiency in Fine Work (H. C. Weston).

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* This article is reproduced, by permission of the Controller of H.M. Stationery Office, from the Report issued by the Illumination Research Committee of the Department for Scientific and Industrial Research. The Illumination Research Committee of the Department was appointed in July, 1923, with the following terms of reference:—

(*a*) To consider and advise on requests from other Departments for investigations in connection with the lighting of buildings and allied problems; and to supervise such investigations if approved by the Advisory Council;

(*b*) To co-operate with the Medical Research Council by making arrangements for and supervising physical investigations needed in connection with physiological researches on illumination;

(*c*) To examine the need for general researches on illumination, to make such recommendations to the Advisory Council as they may consider desirable, and to undertake the supervision of approved investigations.

The Committee is at present constituted as follows:—C. C. Paterson, Esq., O.B.E. (*Chairman*); L. Gaster, Esq.; H. Hartridge, Esq., M.D., Sc.D., F.R.S.; L. B. W. Jolley, Esq.; J. A. MacIntyre, Esq., O.B.E., M.Inst.C.E.; Sir J. Herbert Parsons, C.B.E., D.Sc., F.R.S., F.R.C.S.; A. Alban H. Scott, Esq., M.S.A.; J. S. G. Thomas, Esq., D.Sc.; J. W. T. Walsh, Esq., M.A., M.Sc., A.M.I.E.E.; D. R. Wilson, Esq.

(*d*) The Light Distribution from Industrial Reflector Fitting No. 1 (British Engineering Standard), (H. Buckley and C. J. W. Grieveson).

Further reports will be issued from time to time as results become available.

II—Programme of Work

The following pages contain a brief account of some of the main problems with which the Committee is at present concerned. These problems can conveniently be described as (a) architectural and engineering, (b) physical and physiological, and (c) purely physical.

(a) Architectural and Engineering.

(i) *The transmission of light by various kinds of window glass* (e.g., *clear plate, Hartley's rolled, prismatic, fluted, etc.*).—It is well known that glasses differ amongst themselves in the facility with which they collect dust and dirt, a property which has a direct bearing on overhead charges in large factories with extensive window areas. Apart from this, however, appreciable differences have been found in the amount of light transmitted by various glasses, even when they are clean. This difference tends to become more marked as the light is more obliquely incident on the glass; and as this obliquity is greatest at the bottom of light-wells and in other situations where a maximum access of daylight is most essential, the question of transparency is deserving of study from the practical point of view. Measurements of transparency of various samples of glass have, therefore, been made, and the results will shortly be published in the series of reports to be issued by the Committee.

(ii) *The effect of window-size and of the colour and reflection factor of walls and ceilings on the daylight illumination of deep rooms, particularly in positions remote from the windows.*—The relation of the size and shape of windows and of the nature of the decorations to the illumination available inside a room is a matter of practical interest, especially in factories and in schools, where the design of the building is largely determined by considerations of access of daylight. The influence of these factors is felt chiefly in the case of seats or benches most remote from the window when the available daylight may consist very largely of light reflected from the walls or ceiling. The problem is complex, and many variables have to be taken into account; for instance, the ceiling of a room often receives most of its light by reflection from the ground in the neighbourhood of the window, so that the nature of the ground has an important effect on the results obtained. Experimental work is now being conducted in model rooms, under conditions which permit the size and shape of the windows, the dimensions of rooms, and the decoration of the walls and ceiling to be varied at will.

(iii) *The effect of prismatic glass in deep rooms.*—Another possible method of increasing the available illumination at places most remote from the windows is the use of prismatic glass, so designed as to direct into the back part of the room light that would otherwise be received only in the vicinity of the window. By the study of this subject it is hoped that information may be gained as to the best construction of windows for sub-ground and basement floors, and for rooms in the lower floors of buildings, where light is obstructed by the presence of adjacent high buildings.

(iv) *The design of picture galleries so as to give adequate illumination with a minimum of "glare" due to reflections in the glazing.*—In the picture galleries of large cities it is usually found necessary to glaze the surfaces of all pictures, oil-paintings as well as others, and if other objects in the gallery are relatively bright, objectionable reflections are apt to occur at the glass surfaces of the pictures, particularly when these are dark in tone. Accordingly attempts have been made to design the windows and the system of artificial lighting in such a way as to give adequate illumination of the pictures without at the same time lighting up objects (such as persons visiting the gallery) in the central parts of the room. The problem is a somewhat difficult one, and in general each particular gallery requires special treatment. An account of the work done on this problem will be published shortly as a Report of the Committee.

The following special problems in illuminating engineering have arisen mainly in connection with the work of the Illumination Committee of the British Engineering Standards Association and its sub-committees:—

(v) *The effect of the position of the light source in certain widely used enamelled steel reflectors for industrial lighting.*—The desirability of effectively screening the light source, so as to eliminate glare, has been emphasized in the reports of the Home Office Departmental Committee on Lighting in Factories and Workshops. This investigation is concerned mainly with the problem of standardizing reflectors used for industrial lighting, so as to encourage the production of fittings which are substantially free from the drawback of "glare" or "dazzle." This object may best be secured by ensuring that the bright source of light is situated well within the reflector, so that in all ordinary positions it is screened from the view of the operative. Suggestions arising from a number of tests have been incorporated in the British Standard Specification for Industrial Reflector Fittings for Electric Lighting. Details of the investigation will shortly be published.

(vi) *The relation between glare and visibility in street lighting.*—In view of the growing volume of motor traffic and the large number of street accidents during recent years, increasing attention is now being paid to the provision of adequate public lighting. In many busy streets the maintenance of a higher order of illumination is probably desirable, but it is at least equally important that the illumination should be furnished without undue glare from the powerful street lamps now used. A bright light falling within the direct range of vision of the driver of a motor vehicle may have a temporary dazzling effect, and it is probable that even moderately bright sources, seen obliquely, to some extent impair the visibility of objects in the streets. The problem of providing uniform illumination along the length of the street, and at the same time completely avoiding "glare," is a somewhat difficult one. The investigation proposed to be undertaken is designed to study the effects of glare and arrangements of the light sources in relation to the visibility of objects on the roadway, and to prescribe conditions which would limit, so far as possible, the drawback of glare from street-lighting installations.

(vii) *Temperature distribution in the glass and other parts of lighting fittings.*—In the design of modern lighting fittings, especially those in which powerful lamps are used, distribution of temperature plays an important part. In the case of electric lamps, concentration of heat in certain parts may be responsible for early failure of the leading-in wires; similarly, uniform distribution of heat is a factor in determining the life of globes and chimneys of a "heat-resisting" character. All such problems are now of more consequence than in the past in view of the continual increase in candle-power of modern light sources, usually accompanied by the generation of a large amount of heat. Design must provide for the conduction or radiation of excessive heat, and the study of these conditions is an essential preliminary to standardization.

(b) Physical and Physiological.

In the study of many problems which are partly physiological in their nature, the Committee is receiving the active co-operation of the Medical Research Council, which has also set up a Committee on the Physiology of Vision. Four members of the latter committee, including the Chairman, are members of the Illumination Research Committee, so that ample opportunities are afforded for the exchange of information and suggestions. Amongst various problems of a primarily physiological nature which have been referred by the Illumination Research Committee to the Medical Research Council's Committee may be mentioned:—

(viii) *Investigation of the phenomena of glare.*—Whilst it is a well-known fact that the exposure of the eye to a very bright object (such as the beam of a motor-

car headlight, or a powerful unshaded source of artificial light) causes "dazzle" or "glare," in the absence of any certain test, by which it can be determined whether or no a lighting installation is glaring and liable to cause eye fatigue or injury, such recommendations for the avoidance of glare as have so far been made are mainly empirical. They are based on general experience and form a useful indication of the precautions expedient to minimize the unpleasant effects of glare. Glare, however, is determined by many different factors, the actual brightness of the object viewed, its contrast with surroundings, its distance from the eye and the angle which a line from the eye to the source of light makes with the line of vision, etc. Until all these factors have been fully explored and the physiological nature of glare is understood, it is impossible to frame scientifically derived rules for its avoidance.

This investigation is necessarily a lengthy one, but, if successful, it should lead to results of fundamental importance in illuminating engineering practice.

(ix) *The effect of flicker on vision.*—This problem likewise deserves detailed physiological investigation. The irritating effect of a flickering source of light is recognized, but there is need at present of a definite test by which it can be ascertained if the fluctuation in intensity of light is such as to cause fatigue or inconvenience to vision. The problem has arisen in practice in connection with the use of metal-filament lamps on an alternating current of low frequency; the customary frequency is 50 cycles per second, but in some districts a frequency of 25 cycles per second is used, and effects in this case require special attention. It is also a question of evident importance in connection with the effect on the eye of long-continued viewing of cinematograph films.

(x) *The effect of illumination on the ease and accuracy with which fine work can be carried out.*—This is a good example of a problem which is partly physiological and partly physical in scope. Whilst the response of the eye to higher illuminations is mainly a matter for the study of the physiologist any such investigation must clearly be combined with physical tests, such as measurements of the amount and distribution of the illumination provided. In addition the co-operation of persons thoroughly familiar with the industrial process studied is desirable. At the present time there is a widespread belief that inadequate illumination by imposing handicaps on the worker and destroying the sense of confidence and security upon which efficient work depends is detrimental to expeditious and accurate performance. Few authoritative data on this subject are as yet available, though the question is obviously one of great importance in industry.

The Home Office Departmental Committee on Lighting in Factories and Workshops, in their Third Report issued in 1922, suggested the desirability of experiments in co-operation with the Joint Industrial Councils of leading industries with a view to defining what constitutes "adequate and suitable lighting." To this end the active collaboration of the Joint Industrial Council for the Printing Trade has been secured in an investigation into the process of composing. Informative results have already been obtained in the first stage of this inquiry and will be published shortly.

(c) Physical.

A third part of the programme consisting mainly in the study of methods of measurement or the accumulation of statistical data may be regarded as purely physical. Problems now being dealt with in this section include:—

(xi) *The design and construction of instruments for the measurement of daylight illumination in buildings.*—Daylight illumination is a very variable quantity, altering within wide limits according to the time of day, the period of the year and the climatic conditions. Hence, in studying access of daylight to interiors it is usual to determine the daylight factor, i.e., the ratio between the illumination at a given point in the room and the total unrestricted illumination available at the same moment from a complete hemisphere of sky. The "daylight factor" should thus depend only on the nature of the interior, the size and shape of windows, and the extent to which access of daylight is affected by neighbouring obstructions; it should be substantially independent of the time of day or period of the year, and thus serve as a basis of comparison of means for access of daylight in different buildings. Apparatus already exists for the purpose of measuring this factor expeditiously and accurately, but in the case of a point at some distance away from a low window, where the light reaches a horizontal surface very obliquely, measurement by the ordinary illuminometer method is subject to very large errors. Special apparatus has accordingly been designed for the purpose of making more accurate measurements of this kind.

(xii) *The determination of the average brightness of the sky at various times throughout the year.*—Assuming that the daylight factor for a building has been determined, the probable actual illumination on any day can only be estimated by the aid of a knowledge of the average brightness of the sky throughout the year. Daily measurements, at stated times, of the illumination of a surface exposed to each of the four quadrants of sky facing the cardinal points are now being made. The results are being published year by year in the Annual Report of the National Physical Laboratory, but it is necessary to obtain an average over a number of years in order to eliminate the fortuitous variations due to special atmospheric conditions. It is desirable that data of this kind should be obtained for a number of different parts of the country, in addition to Teddington, but it has not been possible so far to arrange for this.

(xiii) *Measurement of mean spherical candle-power.*—In addition to the above work, most of which is in active progress, a report has been drawn up by the staff of the Photometry Department of the National Physical Laboratory on methods of measurement of mean spherical candle-power by means of photometric integrators of the Ulbricht sphere type. This report will be published in due course. In view of the growing recognition that sources of light should be compared in terms of the average candle-power in all directions, and not on the basis of candle-power in one direction only (which might be liable to give rise to misunderstanding in view of the widely different character of modern sources of light as regards its distribution), it is hoped that this report will serve a useful purpose as a guide to measurements of this kind.

A Study of Shop-Window Lighting in Germany

READERS will recall the Survey of Lighting in 800 Retail Shops, carried out by Messrs. W. J. Jones and H. Lingard, and presented before the Illuminating Engineering Society last year.* It is worth noting that investigations in Germany have been proceeding on somewhat similar lines. An account of a statistical survey undertaken for the Osram G.m.b.H. is presented by Herr Putnoky in *Licht und Lampe* for May 20th. In this inquiry the chief points considered were (1) the Illumination, (2) the Degree of Glare, (3) Conditions of Shadow, and (4) the General Impression, e.g., contrast with surroundings. All these data were assembled in tabular form. The measurement of average illumination in a considerable number of shops is somewhat difficult. It is not usually satisfactory to attempt measurements by observation through the window glass, and it is often not practicable to get access to the inside of the window where goods are arranged. Accurate measurements would also take too much time, if a large number of shops is considered. The judgment was, therefore, based on the impression of the investigators, who adopted several grades in which windows were classified.

Similarly, in regard to glare, letters were assigned for various conditions, e.g., (A) Glare completely eliminated; (B) only slight glare, e.g., that arising from lamps shielded with diffusing or opal glass situated in the periphery of vision; (C) average glare, e.g., bare or frosted lamp situated on the periphery of vision, or

* *The Illuminating Engineer*, May, 1925, p. 119.

lamps with opal bulbs placed in the direct range of vision; and (D) severe glare, e.g., arising from bare or frosted lamps in the direct range of view.

Shadow conditions were likewise ranged in four grades, in the first class being really pleasing effects, with light coming from exactly the right direction, and in the fourth class quite false shadow-effects, such as those caused by lighting units placed much too deep in the window.

In judging general effect attention was paid to the manner in which the window was caused to "stand out" from its surroundings and the degree in which the shop-keeper made use of special light-effects to attract attention, e.g., by employing changing colours.

As a result of all these separate judgments the windows were broadly ranked in three groups, namely: (1) Excellent (free from any serious defects); (2) approximately good, such that defects could be readily put right without any alteration in the general scheme of the installation being needed; and (3) bad. This third group was again divided into two, namely (a) those capable of being put right by various changes, such as the introduction of shielding curtains, the substitution of diffusing glass-ware, the placing of shades in front of exposed sources, etc., and (b) those which were in urgent need of radical alterations, such as the adoption of a greater number of lamps, entirely new fittings and new arrangement of points, etc.

The total number of windows examined (687 in all) fall into thirteen groups, according to the class of trade to which they were devoted. Taking all the windows together, it is estimated that only 3·6 per cent. fall into Class (1), excellent, and only 6·6 per cent. into the next lower class (2) fairly good. Of the remainder, classed as bad, 41·5 per cent. are regarded as capable of improvement, and 48·3 per cent. as being in urgent need of radical alteration.

Of the various classes of shops it is to be noted that only those devoted to jewellery, boots and shoes, and textile goods were considered to contain any examples at all of Class (1). In each case the percentage of windows in this class was about 6 per cent., but more than half were considered capable of improvement, and the proportion of the worst class was relatively low (18-37 per cent.). The other types of shops fell invariably into Classes (2) and (3).

Five types of shops, coming next in order of merit, contained varying percentages of windows falling into Class (2) (fairly good). These come in the following order: Glass and porcelain, flowers, opticians, furniture, food.

The remaining five classes (in order of merit, leather goods, perfumery, decorative and paper, sports goods) contained no windows in Classes (1) and (2), so that all were of Class (3) ranked as "bad"; the proportion regarded as "capable of improvement" varied—the 28 windows devoted to sports and games (*Spielwaren*) having actually 82 per cent. of the worst class (3b) and only 18 per cent. of the Class (3a).

This inquiry related to 224 places of business with 687 windows, all in Berlin, so that some caution is necessary in drawing general conclusions. The results are considered, nevertheless, to show very clearly the great need for a general improvement in shop-window lighting—thus confirming conclusions drawn from recent investigations in this country.

The Artificial Lighting of Shop Windows during Daylight Hours

SOME further experiments on the artificial lighting of show windows during daylight hours were recently communicated to the Illuminating Engineering Society (U.S.A.) by Messrs. W. T. Blackwell and A. S. Turner.

The value of better artificial light at night-time, in increasing sales, is now well recognized. Whether illumination sufficiently bright to be of value during the daytime is commercially justified has yet to be determined, but the authors present interesting experience on this point.

The experiments were made in a department store in Newark, N.J. In order to demonstrate the advantages of artificial lighting it was thought best to utilize a rather narrow and deep window, dark materials such as furs, dresses and hats being displayed. Naturally, the trouble arising from reflections of bright objects, such as sun-lighted walls of buildings across the street, is greatest when the contents of the window are dark in tint. In this case the conditions were regarded as extreme, namely, a black background, dark merchandise, a light building opposite, and a large expanse of sky. If, under these conditions, an increase in custom could be shown to ensue by using a relatively small amount of light even better results might be expected under more favourable conditions. During the test the first week was run with 100-watt lamps in mirrored-glass reflectors on 18-in. centres. During the second week 200-watt lamps on 10-in. centres were substituted, and during the third week the same equipment, plus additional units in the second row on 20-in. centres, was employed. Finally, during the fourth week, the last circuit was turned on, giving an equivalent of 400 watts for every ten inches of window frontage.

A complete record of the number of persons stopping to look at the window was kept—only those who actually stopped to look at the window (not those who paused in their walk or glanced at the window) were counted. The results of the investigation are shown in the accompanying table. With the original equipment (13·5 watts per square foot of floor area) the attracting power of the window was increased 4·5 per cent.; by using 41·7 watts per square foot the attracting power was increased 21·5 per cent.; by using 60·4 watts per square foot the increase was 31·5 per cent.; and by using 79·2 watts per square foot the increase was 37·2 per cent.

It is instructive to note the difference in effect produced during certain periods of the day. It appears that between 9 and 9-30 a.m. very few people are interested in window shopping, so that the increase in illumination did not have much effect. In the periods 10-10 to 10-40, 1-40 to 2-10, and 4 to 4-30 the additional light also played little part in attracting custom. On the other hand, during the half-hour 1-5 to 1-35 the effect of the higher intensities was very striking. In one or two cases it was actually found that fewer people stopped with the brighter lighting, and the precise reason for this has not been discovered. On the whole, however, the effect of greater illumination was strongly in the direction of increasing attention.

It will be noted that in the final column of the table the value of the window, in order to render the increased lighting economical, is calculated. Whilst the actual results of better lighting could presumably only be deduced by actual comparative records of sales, the authors contend that there is every reason to think that even this exceptional illumination during daylight hours is a paying proposition.

TABLE I.

	Additional light employed — Foot-candles Hor.	Vert.	Watts consmp. per sq. ft.	Total No. of passers-by	Persons stopping — Without artificial light	With artificial light	% Persons stopping — Without artificial light	With artificial light	% increase in persons stopping due to artificial light	Approximate cost per day	Value of window in terms of profit per day in order to make light economical
1st week	45	29	13·5	156,932	2,952	2,971	3·69	3·86	4·6	·90	$19·60
2nd week	242	152	41·7	165,192	2,902	3,401	3·46	4·19	21·1	2·81	13·30
3rd week	349	230	60·4	173,357	2,783	3,729	3·24	4·26	31·5	4·09	13·00
4th week	438	287	79·2	182,387	2,503	3,491	2·77	3·80	37·2	5·35	14·40

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Shop-Window Spotlights and Floodlights

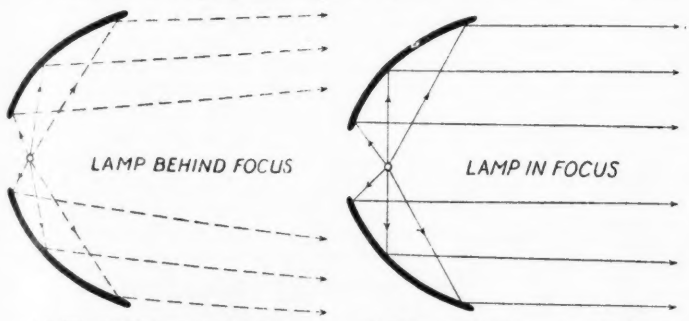
By H. LINGARD

IN a previous article the principles of shop-window reflectors were discussed, and it is now proposed to deal with two forms of accessories that are usually employed in conjunction with shop-window reflectors. The application of spotlights and floodlights arises out of the nature of the window display. In a large number of cases a window is dressed in such a way that certain objects are given a more important position than others, and if artificial lighting can do anything to bring these features to greater prominence, the shopkeeper will usually be willing to invest in the necessary apparatus.

It will be obvious that the requirements of this special lighting will vary, from the provision of a spot of light of high intensity such as would be desired on a small card bearing an important message, to a flood of fairly high intensity to illuminate a draped figure; and it is on this account that the two distinct types of apparatus have been developed.

The essential characteristics of this form of subsidiary apparatus are compactness and adjustability. The first feature is of considerable importance, for the less conspicuous the apparatus the more subtle the effect, while the adjustability of the fitting is of prime importance when the fact is borne in mind that window dressings are constantly changed.

The window floodlight consists primarily of an approximately parabolic silvered reflector, fitted to a bracket mounting, which is usually constructed to allow the reflector to be set in almost any direction, while the lamp is provided with means for adjustment so that the size of the circle of projected light may be varied.



(a) Effect with lamp behind focus *(b) Effect with filament set in focus.*

FIG. 1.—Showing effect of varying the position of Lamp in a Parabolic Reflector.

Fig. 1 indicates the effect of varying the lamp position in a parabolic reflector, and it will be clear that quite a considerable beam-spread adjustment is possible. As a general rule, manufacturers employ standard gasfilled lamps in window floodlights, while provision is usually made for the use of colour screens over the reflector mouth.

The window spotlight, by virtue of its special function of concentrating the light in a strong and narrow beam, is constructed on very different lines from the floodlight. Fig. 2 shows the optical elements of a typical spotlight consisting of a small bunched filament projector-type lamp, a convex lens, and a spherical mirror. It will be seen from the dimensions that the fitting is exceptionally compact, and can be inconspicuously mounted in a window to produce quite startling results.

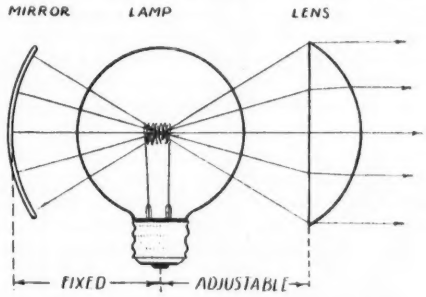
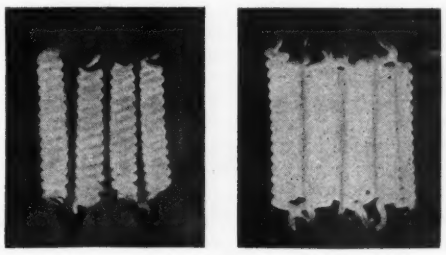


FIG. 2.—Showing Optical Elements of Typical Spotlight.

By allowing a sliding adjustment, as shown in Fig. 2, the beam-spread can be varied within certain limits. The purpose of the mirror is to utilize the light from the lamp which would otherwise be wasted. By using a mirror whose curvature is spherical, and placing it in such a position that the lamp filament is at the centre of the curvature, the light rays striking the mirror are redirected, so that they impinge upon the lens at the same angle as light coming direct from the lamp itself, the effect being that the mirror superimposes an image on the lamp filament in such a way as to increase the apparent area of the filament in the direction of the lens. This is illustrated in Fig. 3, where a simple filament is shown side by side with one on which the image from



(a) Filament only. *(b) Filament supplemented by image.*

FIG. 3.—Showing (a) Filament-coils with interstices between them; and (b) superimposing of image so that these interstices are filled, thus giving an almost solid source.

the mirror is superimposed. It will be seen that the optical system can be adjusted so that the filament image appears between the actual filament itself, so that an almost solid light source is available.

FIG. 4.—Typical Spotlight and Window Floodlight, together with colour accessories.

Fig. 4 shows a typical spotlight and window floodlight, together with colour accessories, and the adjustable mountings giving free movement in almost any direction.

Lamps.—Mention has already been made of the types of lamps employed in window floodlights and spotlights, but a further note will not be out of place. In the floodlight standard gasfilled lamps of from 200-300 watts are most usually employed, although 500-watt lamps are occasionally used. White-sprayed lamps can often be fitted with advantage where evenness of illumination is of prime importance, but since their use tends to spread the beam somewhat they should be employed with discretion.

The 250-watt projector-type lamp gives very excellent results in window spotlights, although most apparatus of this kind is marketed to take either the 100-watt or 250-watt projector-type lamp, the former giving quite good results under many conditions where a less intense beam is requisite.

After-hour lighting can be economically carried out by means of either spotlights or floodlights; for example, quite effective results are easily obtained when a small showcard or piece of merchandise in a darkened window is brilliantly illuminated in an arresting colour by concealed spotlights.

The E.L.M.A. Illumination Course for Women.

IN the past the E.L.M.A. arranged illumination design courses to deal with the general problems of lighting, and among other subjects that received attention was the important one of "Home Lighting." It was felt, however, that the amount of time available to deal with such an important matter was totally inadequate, particularly in these days of rapid electrical development and the projected Electricity Bill.

Home lighting is so obviously a matter in which women can give full play to their artistic imagination that the E.L.M.A. considered that a course arranged expressly for women would prove useful to saleswomen in the electrical industry, and afford an opportunity for free exchange of ideas. Those attending would be able to give helpful suggestions to the lecturers, while the lecturers would be able to disseminate some of the vast accumulation of data and information that is now available at the Lighting Service Bureau, the visitors being the guests of the E.L.M.A. for two whole days.

During the first Home Lighting Course to be held in this country the lecturers progressively dealt with a number of the more important aspects of home lighting, commencing with a survey of the methods of lighting which were employed by our forefathers, and emphasizing the great progress which has been achieved since electric lighting first became an established fact. Electric lighting, to the community, increases the opportunities of social enjoyment, and it adds much to the general comfort of life. Subsequent lecturers discussed the important questions of the process of seeing and the effect of colouring of walls on the resultant illumination, and illustrated some of the modern methods that can be employed in the home. It is regarded as important that women who are called upon to give advice on some of these matters should have, at least, a rudimentary knowledge of these various subjects.

The second day commenced with a lecture on "Light as a Decorative Medium," in the course of which some valuable information concerning the period design of electric light fittings for the home was given, and was followed by an actual demonstration in the revolving house at the Bureau. Here it was possible to definitely indicate the atmosphere which can be created by the intelligent use of electric light, how glare can be avoided, and how electric light can be made to actually take its part in furnishing the home.

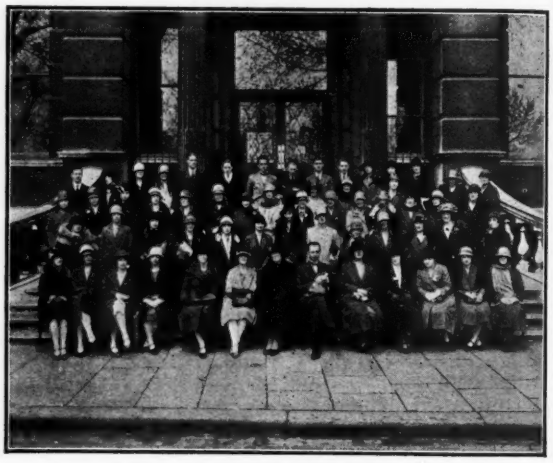


FIG. 1.—Group of Ladies attending the Special E.L.M.A. Illumination Course at the end of last month.

The lectures were concluded by an actual demonstration of methods which could be employed in every electric showroom. The reception room at Savoy Street had been specially equipped for the purpose, and it was definitely proved that the best way of selling light was by showing the actual effects that can be obtained. Numerous suggestions were made regarding display and methods which could be adopted to bring about a better condition of home lighting. The premises at Savoy Street were especially equipped with demonstration cubicles, which convincingly portrayed the difference between poor and effective lighting, and it is anticipated that these lectures will have given the saleswomen of electric lighting fittings the elementary rules which should be followed to obtain good home lighting, and at the same time open up a vista of possibilities which must inevitably give a clear conception of the artistic and practical value of electric lighting in the home.

Throughout the whole of the course the interest of the visitors was maintained, and between each of the lectures ample opportunity was afforded for discussion, permitting the interchange of valuable experience.

The New Post Office Tube

We understand that by the autumn the new post office tube railway for the conveyance of mails in London will be in operation. The existing line, which is 6½ miles long, is practically complete. The ramifications of this tube will link together all the chief post offices of London, and it is expected that the underground cars will relieve the streets by rendering most of the present mail-van traffic unnecessary. An interesting feature of the system is that the cars will be without drivers, being controlled from a central point where the operator, aided by an illuminated diagram, will direct operations.

The Ripening of Bananas

It may come as a surprise to some people to learn that in this country nearly 1,500 million bananas are eaten each year. In "A Thousand and One Uses for Gas" there is an interesting illustrated account of the ripening of this fruit, imported in the green state. Rooms are partially heat-insulated, and automatically controlled flat flame gas burners in wire cages supply the heat that is necessary. The process is quite a simple and inexpensive one. It is stated that in this country there are some 3,500 banana ripening rooms. Only a few days are necessary to effect the ripening and it is stated that the best results are obtained when rooms are completely filled by the ripening bunches, strung on hooks along the walls. In this account, heat is mentioned exclusively as the ripening factor, though illustrations of underground corridors show artificial lighting from bowl units mounted direct on the ceiling. Apparently, however, the lighting is only regarded as necessary to facilitate the mounting or removal of the fruit. As this process is applied to practically all imported bananas, and we are all aware that bananas available form a palatable fruit, one may admit that artificial-heat ripening apparently achieves all, or almost all, that is effected by natural lighting in sunlight. It would be interesting to know, however, whether the processes have quite identical results. It is common knowledge that most artificially treated fruit—for example that raised in hothouses—lacks something of the full flavour of those grown in the open and exposed to the full value of the rays of the sun. This difference has been ascribed to the obstruction of ultra-violet rays by the glass of greenhouses. It is open to importers to make experiments and ascertain whether, by supplementing the heating by exposure to, say, the rays of a quartz-tube mercury-vapour lamp, or other source rich in ultra-violet rays, "super-bananas," at least in regard to flavour, could not be put upon the market!

Smoke Abatement and Relief of Housework

The great coal strike has naturally served to bring before the people's mind the drawbacks of using coal on the domestic hearth. In a letter written in the interests of the Smoke Abatement Movement Dr. C. W. Saleeby draws attention to the great increase in household labour arising from this practice:—

"Coal fires mean work and dust. They are unhygienic because they foul the air and obstruct the antiseptic action of sunlight. It is distressing to see a woman dust a room. She mops up a little of the dust into the folds of her duster, and all the remainder is simply scattered about the room. Unless direct sunlight, unrobbed of its antiseptic ultra-violet rays by smoke, has reached this dust, it is probably laden with myriads of noxious microbes. Twenty minutes' work with an electric vacuum cleaner means a room hygienically swept. The modern gas fire or gas cooker spells cleanliness and health with a minimum of work."

Dr. Saleeby adds:—"I am one of the freaks who practise what they preach, having never bought an ounce of coal in my life!"

London's Underground Main Service

Few people who benefit by the ready use of gas for lighting, heating and cooking realize the complexity of the distribution system by which it is made available. A party of fifty students in gas supply from the Westminster Technical Institute, accompanied by Mr. E. L. Oughton, the Senior Lecturer on Gas Supply (who is also associated with the South Suburban Gas Company), recently visited the subways in the City of London in order to examine methods of main laying and distribution. The party were conducted by Capt. W. J. Liberty, Public Lighting Inspector of the City of London, to whom a vote of thanks was afterwards proposed by Mr. Oughton. A visit to these "underground streets" where mains are placed is of considerable educational value.

The George Montefiore Triennial Prize

We understand that the George Montefiore Triennial Prize, offered for the best original work presented dealing with scientific progress and advances in technical applications of electricity, is now again to be awarded. The prize is based on the accumulated interest on 150,000 francs invested in Belgian 3 per cent *Rentes* and is awarded every three years. Contributions are judged by a jury consisting of ten electrical engineers, of whom five are Belgian, and five drawn from other countries, presided over by the Director of the Institut Electrotechnique Montefiore.

Fuller particulars are obtainable on application to the General Secretary, Siege Social, Rue Saint Gilles, 31, Liège, Belgium.

Slow Motion Pictures as an Aid to Research

Yet another instance of the value of a series of successive photographs, run at a slow speed, in revealing phenomena that would otherwise have escaped undetected, comes from U.S.A. In some recent experiments on circuit breakers it was thus discovered that there was a pause and an actual reversal of the moving contacts during the opening cycle. This effect was quite unsuspected and could hardly have been discovered otherwise, and proved to be due to a special feature in the design, readily corrected once its existence was demonstrated.

Ultra-Violet Light as an Aid to Detection of Crime

According to the Berlin correspondent of *Modern Sunlight*, a quartz lamp is now to be found in almost every German police station. The fact that "faked" gems can often be detected from the genuine variety by means of the fluorescence caused by ultra-violet rays is well known. It is stated that whilst genuine diamonds glow brightly, faked diamonds remain lifeless under the rays, and advantage has been taken of this in many cases of fraud. Again, many aniline dyes fluoresce brightly under the rays, and this has several times enabled the police to discover minute fibres from the clothing of criminals detached by the incidental rubbing of their clothes against doors or window frames. For such cases the ultra-violet lamp is sometimes more valuable than the microscope.

Ultra-violet rays are also playing a useful part in facilitating the deciphering of old manuscripts. Professor Koegel, of the Karlsruhe High School, is mentioned as one of the pioneers in this field.

Gas Lighting in Hyde Park

According to all accounts, gas did useful service in providing emergency heating and lighting during the strike, for instance in Hyde Park, used as a milk-distributing centre, where many workers were installed. At once H.M. Office of Works applied to the Gas Light & Coke Co. for assistance, and men and materials were dispatched to the scene of operations. The Park was divided into sections, in each of which there was a central office to be lighted. There was also a number of marquees, some 90 ft. in length, that required illumination, and the canteens also needed a supply of gas for cooking and heating water. The Park itself is lighted throughout by gas, so that there were certain points available from which pipes to the various centres could be run. The work commenced on May 3rd, and as the strike proceeded conditions became more complete and efficient. In all, something like 5,000 ft. of piping was laid, and about 120 lamps were installed in the various marquees and offices.

The Restoration of Public Lighting in Berlin

In a paper recently read before the Illuminating Engineering Society in Germany, Herr G. R. Mylo reports that substantial progress is being made towards the complete restoration of normal public lighting in Berlin. During the very darkest period, in April, 1924, there were in use 4,600 lamps, consuming 525 kw. In July, 1925, the number of lamps in use had risen considerably, consuming 1,495 kw.—a very substantial improvement. At the present time there are about 8,000 electric incandescent lamps in use for public lighting in greater Berlin, and there have hitherto been also about 600 flame arcs rated at 3,000-5,000 H.K. More recently many of these lamps, which are about 10 years old, have been replaced by the new long-burning flame "Dia-Carbone" arcs, introduced by Messrs. Körting & Mathiesen. With these new lamps a considerable number of experiments are being made in Berlin and elsewhere. Dr. Mylo emphasizes the very important part played by simple forms of illumination-photometers in enabling public lighting officials to study conditions of illumination in their streets. In Germany a number of officials have recently purchased instruments of this type.

Of special interest is the account given by Dr. Mylo of methods of using light for the guidance of traffic. The use of concentrating reflectors (*Tiefstrahler*) over islands has become usual. In this way the island can be flooded with light and its boundaries clearly seen. Luminous traffic signals are also coming into general use. One of these is the luminous hemisphere, mounted on the road to indicate the course of traffic, and so strongly built that it will withstand being run over by a motor-lorry! To mark out stopping places for trams, rectangular luminous columns are being used. These are internally lighted. At the summit of the column is a plate indicating that this is a stopping place. But the four sides of the column are occupied by pictorial advertisements, so that it adds considerably to the brightness of the street. Yet another interesting novelty is a small hexagonal island carrying four horizontal diffusing-glass panels, below which powerful lamps and reflectors are concealed. The officer controlling traffic stands at the centre of this island, and the light streaming upwards illuminates his figure and enables all his motions to be clearly seen.

A Well-Lighted Show-Window

There is no doubt that the effectiveness of a window depends to a considerable extent on its contents. When a draper, for instance, contrives an exceptionally pleasing and effective colour-display, a good opportunity is afforded for the lighting engineer to show his skill. It is sometimes thought that in dealing with prosaic materials, such as groceries, there is less scope. The accompanying photograph shows, however, what can be done with simple materials. This is a demonstration "Gecoray" window of the Glasgow Branch of the General Electric Co. Ltd. The window is flooded with light and makes quite an effective display.

Flood-Lighting at Euston Station

A wide field undoubtedly exists for flood-lighting of a "directional" type, i.e., calling attention to the presence of a building, or imparting some useful piece of information. On the railways this device is of special value. The accompanying illustration shows one or two such signs outside Euston Station. Each is flood-lighted at night by two G.E.C. flood-lights equipped with 500 watt Osram gasfilled lamps. The signs are fitted so that they indicate the entrance, from whatever direction the station is approached.

Spring Cleaning: Clean Up! Paint Up! Light Up!

The above motto formed the basis of a judicious leaflet recently circulated by an American undertaking, the Union Gas & Electric Company. The idea it conveys is one that might well be pondered in this country. There is a curious impression that once the summer comes the lighting season is "dead," and it is doubtless true that owing to the longer daylight hours, accentuated by the "Summer Time Act," less gas and electricity is used for lighting purposes.

But does it follow that the opportunities for improvement in lighting installations are less? Hardly. The early summer is the time when many householders undertake renovation and spring-cleaning—and this is the very time when an enterprising manufacturer should be urging the advisability of clearing out obsolete lamps and fittings, and removing defects in lighting installations. To the lady of the house any disturbance involved in rewiring or repiping is a serious matter. When walls are about to be repapered she may respond to a suggestion that fittings should be relacquered, or more modern glassware installed, or even the positions of lamps altered. But it may be taken for granted that a little later, when the scheme of redecoration is complete, she will turn a deaf ear to any suggestions of this kind!

From personal knowledge the writer can also affirm that the later summer months are the best in which to approach those associated with schools and colleges. During the term they are immersed in routine work and unwilling to consider changes. During the vacation there is an opportunity of taking stock and reviewing possible improvements. The same applies, to a great extent, to commercial undertakings and factories. As a rule the pressure is less during the summer. Managers have more leisure to consider improvements. As a rule by the autumn they have either decided what improvements are necessary, and probably started them, or they are disinclined for any upset of routine and defer the matter until "things are slack."

Improvements in Public Lighting at Health Resorts

THE authorities of seaside towns and other health resorts are beginning to appreciate more fully the importance of making their sea fronts and other thoroughfares attractive at night-time by the provision of lighting installations which are brilliant and dignified. The south foreshore at Scarborough, views of which have been published in previous issues of *The Illuminating Engineer*, is a good example of the manner in which the sea front can be made beautiful at night-time by the provision of suitable gas lamps arranged correctly on columns of the proper height, properly spaced.

FIG. 1. The "Grosvenor" Gas Lamp.

FIG. 2.—The "Littleton" Gas Lamp—bracket type.

Scarborough was one of the first seaside towns to bring about the necessary improvements in its promenades and streets, and Southport, Llandudno, Weston-super-Mare, Clacton-on-Sea, Whitley Bay, Colwyn Bay, Ilfracombe, Leamington Spa, Filey, Swansea, Dalkey, and Margate may be mentioned as some of the many other towns which can boast of very fine examples of modern gas lighting in their principal and other thoroughfares.

The gas lamps which are being used for effecting the improvements in the lighting of these towns are mainly "Littleton" and "Grosvenor" lamps, of which illustrations are shown in Figs. 1 to 4. The "Littleton" lamp for street lighting is designed in three forms—suspension, bracket and upright—and is made in sizes to accommodate from one to fifteen No. 2 size mantles. In its upright form it is placed directly on top of the column. This form of circular lamp is now preferred to the square type of lamp on account of its

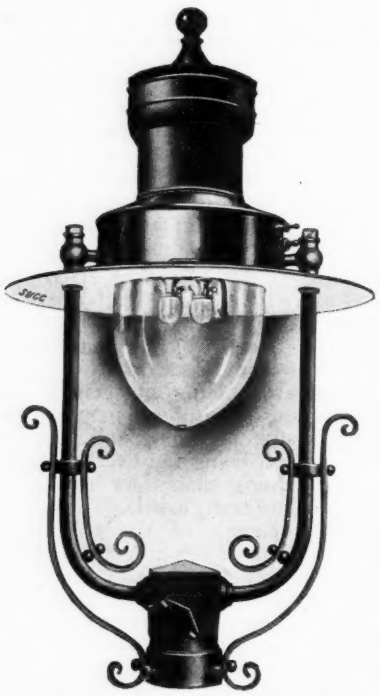


FIG. 3.—The "Littleton" Gas Lamp—upright type.

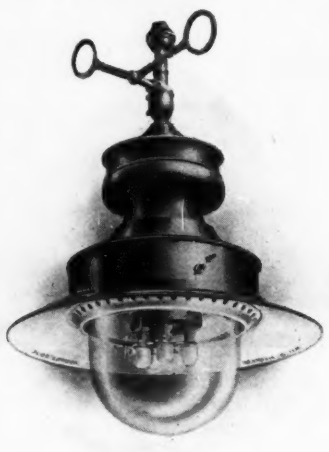


FIG. 4.—The "Littleton" Gas Lamp—suspension type.

symmetry, its freedom from shadows and its lower maintenance costs; that is to say, the lower costs involved in cleaning and glass replacement. The advantages of the lamp are so great that quite a number of authorities have adopted it even in by-streets where square lamps might, perhaps, have been considered sufficiently good. Other authorities have taken up an almost similar attitude, but have preferred to have the lamp supported on a swan-neck or a harp fitting on the top of the column.

The "Grosvenor" gas lamp is another very efficient street-lighting unit with bent tapered-glass panes. A typical installation of these lamps is to be found on the promenade at Weston-super-Mare, where about 60 are in use, each carrying a cluster of eight No. 2 size mantles. A great number of "Grosvenor" lamps are used for the lighting of Metropolitan boroughs. Both the "Littleton" and the "Grosvenor" lamps are fitted with superheaters, which ensure very high efficiency from the gas used. At important road junctions, and in other positions in which a single "Littleton" lamp of even 1,500 candle-power is not sufficient, many towns have two- or

FIG. 5.—Nine-light upright "Littleton" Gas Lamps are used for the lighting of the Marine Terrace, Margate. The existing columns were utilized for the new and more powerful lamps, but the height of the columns was increased by the addition of a 3-ft. extension piece.

three-way standards, and use duplicate or triplicate lamps in either upright or suspension form, the three lamps giving up to 4,500 candle-power as desired. There is no reason, of course, why the number of lamps on one standard should not be even greater, the only limit to the number being the number of bracket arms that can be disposed artistically around a column, either all on one level or in tiers. In footways in which the avoidance of columns is desirable, the suspension type of lamp can be fixed on wires stretched across the road from building to building, traversing and lowering gear being provided for use when the lamps require cleaning or other attention.

The suspension lamp, with clear glass, gives its greatest duty immediately under the mantles, but a curve of fine uniformity can be obtained by frosting the lower part of the globe; many authorities are now using globes of this type, frosted half or two-thirds up from the bottom.

The "Littleton" lamp, with ten or more mantles, is made with divided super-heaters which afford central ventilation. This arrangement does not involve the use

FIG. 6.—The Marine Terrace, Margate, showing the Jubilee Clock Tower lighted by four 9-light "Littleton" Suspension Gas Lamps.

of more than one by-pass jet to light up the whole of the burners in the lamp.

With the advances in gas lighting indicated in the above notes, and the ease with which existing lamps can in many cases be converted, it is difficult to understand the reason why upright incandescent gas burners are still in use in a few towns. In many cases the cost of fitting up the lamps with inverted burners can often be more than covered by the saving in gas consumed by the new burners during the first year of use, as the following figures will show:—

Ten lamps with upright mantles would consume about 50 cubic feet of gas per hour. The same lamps with twin bijou inverted cluster would give 25 per cent. more light, but would consume only 35 cubic feet per hour; therefore, in a lighting year of 4,000 hours, 60,000 cubic feet would be saved, representing, with gas at 3s. per 1,000 cubic feet, £9, from which can be deducted the cost of conversion (50s. for the 10 lamps), showing a nett saving of 13s. per lamp for the first year, and 18s. per lamp for every subsequent year.

FIG. 7.—The Jetty, Margate, lighted by 36 "Rochester" Gas Lamps, each fitted with clusters of 12 No. 2 gas mantles.

As evidence in support of the above statement, the following figures, which appeared in a report of the city fathers of Newcastle-upon Tyne, may be quoted:—

The number of lamps converted was 8,439.
Capital cost of conversion, £2,431.
Saving in mantles and gas in the first year, £5,307.
Nett saving, therefore, £2,876 in the first year;
And subsequent years, £5,307 per year.

The accompanying illustrations show views of recently remodelled terrace and jetty lighting installations in Margate. The Marine Drive, Marine Terrace and Marine Parade, Margate, are lighted by "Littleton" lamps, each fitted with a cluster of nine mantles. The height of the columns is 12 feet above pavement level, and the distance apart of the lamps is about 36 yards.

The jetty at Margate is about a quarter of a mile long, and is beautifully lighted by 36 12-light "Rochester" gas lamps, evenly spaced from end to end on the hit-and-miss principle. The illustrations of gas-lighting installations which accompany these notes were all obtained in Margate.

These installations leave little to be desired from the illumination point of view. All that remains to be said is that every installation must, of course, be properly maintained. Without efficient maintenance, the finest installation in existence will not give its best for long. In this connection it may be stated that the lamps described can be maintained in good condition easily and at a comparatively low cost.

It will be seen, therefore, that gas lighting is well adapted to meet the needs of seaside and health resorts, and many other instances of its successful use, besides those alluded to in these notes, could readily be mentioned.

The Offices Regulation Bill

A Much Needed Measure

WE have received from Mr. Wm. C. Keary, the General Secretary of the National Federation of Professional Workers, some notes on the Offices Regulation Bill, a much needed measure which the Federation is sponsoring.

There is no single factor more conducive to ill-health among office workers than continued hours of employment in badly ventilated, overcrowded, insufficiently lighted and insanitary premises. Thanks to the Factory and Workshops Acts the terror of such employment has been largely removed from our factories and workshops. But, unfortunately, in a considerable number of offices throughout the country such conditions prevail. The standards have become so low, both figuratively and actually, as the practice of burrowing deeper and deeper into the earth in crowded centres continues, that an enormous amount of preventable ill-health to office workers can be directly traced to the deplorable conditions of office accommodation. Overcrowding in many offices since the termination of the war has become chronic. Cubicles are added to cubicles, until prison cells have become, from the health standpoint, almost luxurious by contrast. Since the immense influx of women into office life in recent years practically nothing has been done to increase sanitary accommodation. In many cases there is no attempt to keep the passages and walls in a cleanly state, or to prevent the growth of disease in dark corners. The maintenance of a reasonable temperature, such as is insisted on in the case of factory legislation, is in thousands of offices not provided for in any way. Lighting arrangements are frequently defective, resulting in serious eye-strain and nervous disorder. There is inadequacy of provision of means for escape in case of fire and harrowing tales could be told of office workers imprisoned beyond hope in such awful emergencies.

It may come as a surprise to many that in several of the public services the conditions are nearly as deplorable as in offices under private control. People, when speaking of, for example, the Civil Service, think of the front rooms in Whitehall and are more or less unacquainted with the miserable, damp, unhealthy accommodation frequently accorded to, say, Customs Officers at the ports, or the sickly dark kennels in which many of those engaged in inland revenue duties and in the work of labour exchanges throughout the provinces have to spend their working hours. Cuts in expenditure on such services have been secured in several instances by the maintenance of premises never intended for permanent habitation.

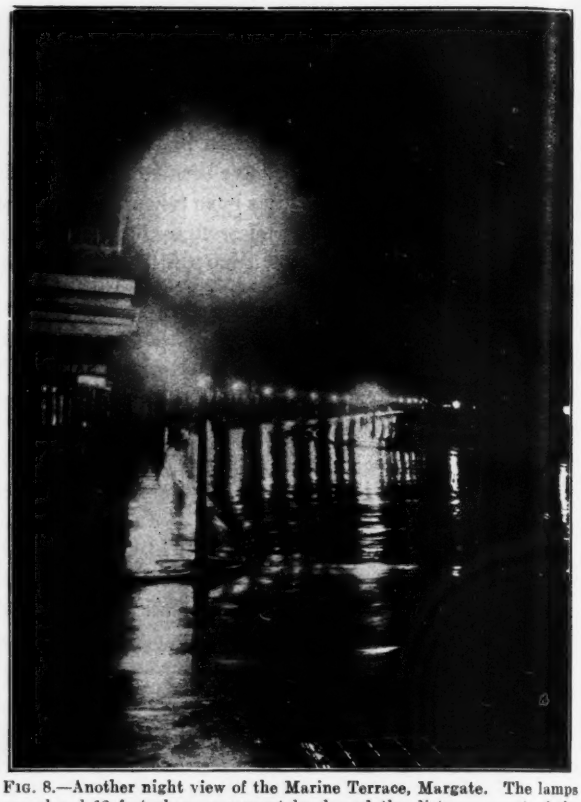


FIG. 8.—Another night view of the Marine Terrace, Margate. The lamps are placed 12 feet above pavement level, and the distance apart of the lamps is about 36 yards.

In regard to those engaged in private employment, when you see multitudes of pale-faced clerks, victims of tubercular and nervous trouble, you may be sure that the impure air and unhealthy conditions of offices play a large part in the holocaust. The effects are no less terrible because the features are insidious. There is a ray of hope to these workers in the representation to Parliament this year of the Offices Regulation Bill, as promoted by the National Federation of Professional Workers.

The Bill provides for satisfactory attention being given to important and necessary provisions, such as specific minimum standards of cubic air space, restriction of the growth of underground offices, measures to secure cleanliness, a minimum scale of sanitary conveniences, the maintenance of adequate lighting, temperature, etc., and includes the necessary provisions for inspection by local authorities. There is also a much needed clause regarding restriction of employment of young persons, who are often employed under an age at which they would be admitted to a trade or recognized profession, and who are frequently employed continuously without suitable intervals for meals.

The Bill has the support of the medical profession, including many medical officers of health, sanitary authorities and inspectors, health visitors, industrial welfare workers, architects, lighting and ventilating engineers, and the organizations associated therewith, in addition to influential members of private and public corporations and the public. The most recently compiled mortality figures prove conclusively that the health of a large section of ordinary commercial office workers is far below the standard which could be easily attained by proper safeguards, being nearly twice that of groups working under healthy conditions. The statistics of the nature of the complaints from which they suffer is also conclusive of the conditions which operate, fully one-third of the deaths being attributable to tubercular and respiratory diseases.

The congested state of parliamentary business has not yet permitted a second reading of the measure before Parliament. It is the hope of every office worker throughout the land that facilities will be given by the present Parliament at an early date for the passage of the Bill.

Safety Rules for the Installation and Maintenance of Electrical Supply Stations.

UNDER the above title, No. 6 of the Handbook Series of the Bureau of Standards (Washington) has appeared. The booklet has been issued in response to the demand for a smaller version of the complete code; accordingly the fourth edition has been issued, not as a whole, but as separate publications dealing with the various subjects covered. This volume contains Part I, dealing with generating stations and sub-stations, along with grounding rules. The rules have recently been revised. Two sizes of type are used, the larger containing the rules proper, and the smaller used for explanatory notes. Following a series of definitions of essential terms, rules in the interest of safety are set out in a comprehensive series of sections (90—184).

Of special interest are those bearing on illumination. For rooms and spaces occupied by electrical apparatus or machinery the following values are specified:—

	Illumination (foot-candles). Minimum.	Modern Practice.
(1) Switchboard instruments, gauges, switches, etc.	1	2—4
(2) Switchboards with no exposed parts	½	1—2
(3) Storage Battery Room	½	1—2
(4) Generating Room, Boiler Room, Pump Room	1	2—4
(5) Stairways and Passages, where there is moving machinery, exposed live parts, hot pipes, etc.	1	2—4
(6) Any traversed space	¼	1—2

N.B.—Illumination is to be measured at working surfaces, except in (5) and (6), when measurement is made at floor level.

The means of illumination must be maintained ready for use at all times. A separate emergency source of illumination from an independent generator, storage battery, gas main or lantern (the two latter should never be used in battery rooms) must be provided at every station where there is an attendant. Portable cords attached to fittings, etc., must not be brought into dangerous proximity to live or moving apparatus. All lamps should be so arranged as to be controlled, replaced or trimmed from safely accessible places. Portable conductors shall be attached to fixed wiring only through separable attachment plugs which will disconnect all poles by one operation.

These special regulations for generating stations deserve special notice in view of the vital functions they perform and the great dangers that may be occasioned by inadequate illumination of all places where "live" metal surfaces exist.

A Sense of Proportion in Selling

Under this title the *Electrical World* draws attention to the prevailing idea that a sales organization is efficient when sales promotion expenses form a very low proportion of the gross sales or total revenue. In many stores, devoted to furniture, jewellery and other specialities, 10-12 per cent. is usual. But in the case of many supply undertakings 1-2 per cent. for total sales promotion expenses, and perhaps 0·25-0·5 per cent. for advertising and publicity, is often found. It is suggested that, for the sake of producing a good factor, sales expenditure is often starved. A sales promotion expenditure of say 1 per cent. of gross revenue may seem economical, but if, as often happens, the annual growth in income is only 10-12 per cent. one may suspect that the economy is overdone. Our contemporary's remarks were applied to American supply undertakings. If their propaganda expenditure is considered inadequate, one wonders what the corresponding figures would be in this country!

An Example of Flood-Lighting in Holland

Instances of the growing use of flood-lighting continue to reach us from different parts of the world. The two accompanying illustrations show the illumination of the old Town Hall, during a recent patriotic festival held in the quaint Dutch town of Gouda, which is known all over the world for its "Gouda cheese."

FIG. 1. General view of Gouda Town Hall, flood-lighted at night.

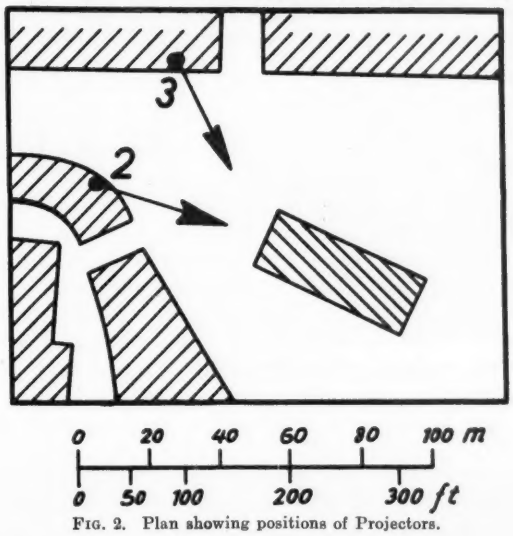


FIG. 2. Plan showing positions of Projectors.

This Town Hall dates back to 1458, and is executed in late Gothic style. This style, with its many architectural details, offers good opportunities for flood-lighting, which was also aided by the good reflecting power of the grey sandstone used for this building.

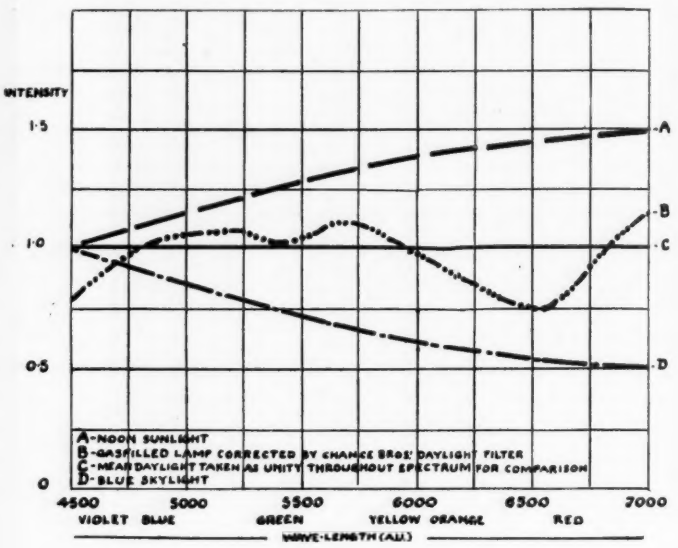
The lighting was effected by five X-ray projectors with vertical type 1,000-watt projection lamps. The Philips Lighting Bureau was in charge of the equipment, which proved a great success. Fig. 1 shows a general view of the hall, flood-lighted at night. Fig 2 indicates the positions assigned to the projectors, two being mounted on the roof of one house and three on another house at the opposite side of the street leading to the Town Hall Square.

Colour Matching by Artificial Light

THE number of "artificial daylight" units in use in the textile industry is constantly increasing, but their development would probably be more rapid if the degree of accuracy claimed for various units was more fully substantiated by precise data. For this reason it has often been urged that firms manufacturing this form of apparatus should furnish curves showing the degree of resemblance to average daylight. The whole question needs to be considered in relation to the purpose the "daylight" unit is to serve. In the dyeing and textile industries the greatest possible precision is desirable. For many other purposes, however—for instance, in art galleries, drapers', florists' shops, etc.—consumers might be satisfied with a lower order of accuracy in view of the fact that the sacrifice of light occasioned is then less.

The publication of a curve enables an expert to forecast the possibilities of an artificial daylight unit, and to say with very fair certainty for what processes it can best be used. In the absence of such data it is often difficult to say whether a unit will answer for accurate work—though it may be said that one occasionally sees so-called "daylight units," which can be recognized by mere visual inspection to depart very widely from average daylight! At the same time it must be recognized that the term "average daylight" requires definition. Most authorities consider that for colour matching the light from a white north sky is best. Direct sunlight and light from a blue sky are both distinctly different.

The adjacent diagram shows the distribution of light in the spectrum of the Benjamin Daylight Unit, utilizing light from a gasfilled electric lamp, filtered through Chance's daylight glass. At the extremes we have the



curves for noon sunlight (A) and blue-sky light (D). Intermediate is the average daylight, taken as the horizontal straight line (C), and the artificial daylight unit (B) is designed to approach this quality of light as closely as possible.

Photochemical Research

ONE of the most interesting new fields of experiment, opened out by the introduction of efficient sources rich in ultra-violet light, is the application of light-rays, visible and invisible, for chemical processes. There are some cases of light being used for established processes in industry—e.g., for the sterilization of water and the tanning of leather. But it is probable that there are many at present unsuspected applications of the short wavelengths which will become apparent only when the action of these rays is more fully understood. One of the most familiar illustrations of their chemical action is in causing the fading of colours. Researches have shown, however, that different artificial sources of light vary considerably in their effect on different colours; it is not even clear that the range of radiations most potent in causing fading of one particular variety of colours will also be the most active for other hues. This consideration, alone, shows how greatly chemical actions may depend on the exact nature of the radiation to which they are exposed.

For the moment experimenters in this new field are confining themselves chiefly to fundamental principles, analysing well-known photochemical effects and trying to discover exactly how they occur. In *Modern Sunlight* Mr. L. T. M. Gray, of King's College, gives a summary of some of the chief investigations now proceeding. Research on photographic effects of light has been continuing persistently for years; work, for instance, is being done by Luppo-Cramer in Bavaria, by Lumière in Paris, and by the Eastman Kodak Co. at Rochester, N.J.

At Liverpool Professor E. C. Baly is engaged in the study of photosynthesis, of which the most familiar example is the building up of materials by plant life. By the action of ultra-violet radiation he has been able to build up formaldehyde, which is generally considered to be the first stage towards more complex products. At Oxford, Messrs. M. C. Chapman and D. L. Chapman are studying the reaction between hydrogen and chlorine to form hydrochloric acid gas—an action which takes place with explosive violence under the action of light, though the precise rays necessary and their manner of action are not yet clearly understood. It is conceivable that a fuller knowledge of this process might have important consequences—for instance, in suggesting how other chemical reactions might be very speedily and simply brought about. At Oxford University and at Cambridge—where Professor T. M. Lowry is engaged on photochemical research on organic compounds—work is being done. Other centres of experiment mentioned are Leipzig, Göttingen, Berlin, Utrecht, Copenhagen, Moscow, Zürich, Princeton (U.S.A.) and Allahabad. Research in this field is thus extensive and international; it may lead to valuable developments in time to come.

TRADE NOTES & ANNOUNCEMENTS

THE NEW METRO-VICK SHOWROOMS.

In our last issue reference was made to the tendency of leading electrical firms in London to move westwards, as illustrated by the opening of the new "Metro-Vick House" in Charing Cross Road. The new premises were displayed to a representative gathering of journalists on April 19th. We are now presenting a view of the main showroom, with its ample space for the display of fittings and fine central show-case, which is one of the most imposing rooms in the buildings.

The New Metro-Vick Main Showroom.

M.V. SILVERSTONE GLASSWARE.

An attractive trade catalogue, with a pleasing wrapper in colours, has been issued by Metro-Vick Supplies Ltd. dealing with the M.V. Silverstone Glassware. This is supplied in a variety of forms, some of the most effective being the closed bowls of diffusing glassware with ornamental pattern. We understand that fittings of this nature have been installed on an extensive scale in Messrs. Swan & Edgar's new Piccadilly building, and in Messrs. Thos. Cook & Co.'s new premises in Regent Street, and other well-known interiors. Special fittings are also being supplied for Messrs. John Barker's new store in Kensington, whilst for the new Plaza Theatre (Regent Street) Messrs. Metro-Vick Supplies Ltd. furnished all the outside wrought-iron bracket lanterns, which are faithful reproductions of a famous old Venetian model, adapted to electric light.

"COSMOS" ELECTRICAL ACCESSORIES.

Two catalogues are to hand from Messrs. Metro-Vick Supplies Ltd., devoted respectively to electrical accessories (Section B) and electric kitchen equipments (Section L). The former includes an up-to-date list of lampholders, adapters, wallplugs and sockets, rotary switches, etc. We notice that a special feature is made of switchplates of the flush pattern, now generally preferred by architects. The second list is also a complete one. Both are conveniently arranged and exceptionally well printed.

SIEMENS "ZED" FUSES.

A list just issued by Messrs. Siemens and English Electric Lamp Co. Ltd., deals very fully with "Zed" fuses and accessories. Characteristic curves relating to amperes and cold minutes are reproduced for 250, 500 and 750-volt cartridges, and fuse fittings and insulators for overhead lines are also listed.

GAS LIGHTING AT HOME AND ABROAD.

Reference was made in our April number to the pleasing booklet issued under the above title by Messrs. Wm. Sugg & Co. Ltd. This contains over 150 illustrations, drawn from many parts of the world, mainly representing public lighting with gas. In a number of cases day and night views are reproduced side by side, and in the accompanying two pictures we have selected two of the most striking. In booklets dealing with lighting installations it is not unusual nowadays to find pictures which are both instructive and pleasing, but it is not often that one comes across a view so artistic as that of Magdalen Bridge by night. The view of the bridge by night is, of course, a famous one, and in this case the photographer seems to have been very happy in the selection of the conditions, showing the church tower with a sunset behind. The pictures also show, in a very striking manner, how very different are the conditions in most streets by day and night.

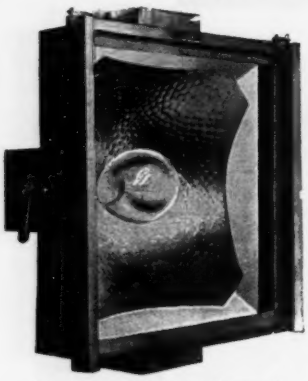
Many of the other views in the book are curious and interesting, particularly those relating to the East. We understand that Messrs. Wm. Sugg & Co. contemplate the issue of a second booklet dealing with the lighting of shops, factories, schools, churches, etc., in similar form, and this would be very welcome.

Magdalen Bridge, Oxford, by day.

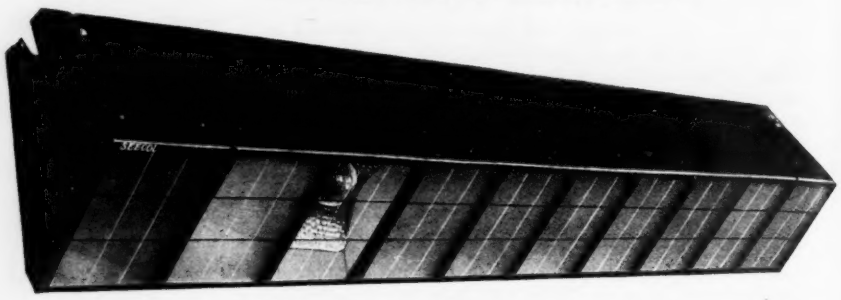
Magdalen Bridge, Oxford, by night: Gas Lighting with "Grosvenor" Lamps.

"SUNRAY" STAGE-LIGHTING APPLIANCES.

We are reproducing below views of the "Sunray" lanterns and stage-lighting battens, exhibited by Mr. L. G. Applebee at the recent meeting of the Illuminating Engineering Society, on the occasion of the discussion of Stage Lighting. We understand that these are amongst the most widely used of the special stage-lighting equipment supplied by the Strand Electric and Engineering Co. Ltd., a feature being the wide distribution of light effected with these reflectors.



(*a*) The 17-inch "Sunray" Lantern, designed for 500 or 1,000-watt gasfilled lamps, with the "Sunray" Reflector."

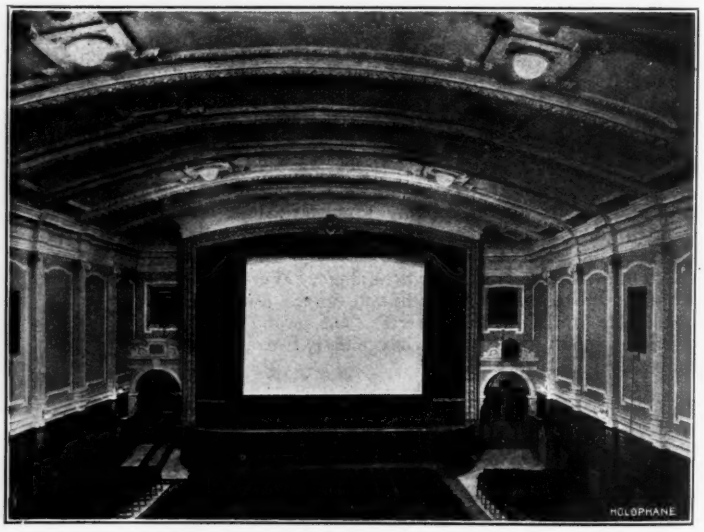


(*b*) "Sunray" Stage Batten, designed for 60, 100, or 150-watt gasfilled lamps, colours being obtained by the use of non-inflammable gelatine sheets; each lamp having a "Sunray" Reflector.

The opening of the season at Covent Garden, as usual, afforded good opportunities for special lighting effects. In particular, the lighting of the "Ring" series of operas attracted notice. We are informed that the special lighting effects were arranged by Mr. Charles Moore, the well-known Continental producer, in conjunction with Mr. Webber, the resident engineer, and Mr. L. G. Applebee, who made use of some of the "Seecol" optical-effect machines (also shown before the Illuminating Engineering Society). Special features were the "fire" scenes in "Die Valkyrie" and "Gotterdämmerung," which were entirely rearranged.

AN EFFECTIVE KINEMA THEATRE INSTALLATION.

During recent years the method of artificial lighting in kinema theatres has assumed much greater importance than in the past. We have here a special problem, one feature being the necessity of keeping lights completely out of the range of vision of the spectators looking towards the screen; pendant chandeliers, etc., are here out of place, and diffusing bowls are frequently mounted direct on the ceiling. The illustration shows the arrangements adopted in the Apollo Kinema, Southsea, one of the first picture houses to adopt Holophane lighting. Another feature of this installation is the introduction of colour in the general lighting—now a favourite device in the picture theatre. The main "white" lighting is carried out by a number of 20-in. Holophane Hemisphere units, and the photograph gives a good idea of the diffusion of light thus obtained. But Holophane prismatic colour units have now been adopted in place of the subdued lighting system formerly used, and these decorative units are now being very widely employed in installations of this kind.



The Lighting of the Apollo Kinema, Southsea.

THE STRENGTH OF MODERN LAMPS.

One of the Osram lamps installed in the machine-room of *The Daily Express*, in St. Bride Street, London, was recently involved in a curious accident. Several hundredweights of spelter ran over a lamp immediately below one of the machines; yet, when tested, the lamp subsequently lighted up. The incident illustrates the improved durability and robustness of modern electric lamps.

A VERSATILE GALVANOMETER.

A leaflet issued by the Cambridge Scientific Instrument Co. Ltd. draws attention to a versatile galvanometer now developed. This provides for a wide range of measurements. There is a millivolt scale for direct-current measurements and a thermal scale of similar range for alternating-current work. Direct currents as small as 2 microamperes or as large as 24 amperes and direct-current pressure from 20 microvolts to 600 volts can be measured. The range for alternating-current measurements is not quite so great, but still very extensive. The instrument has various useful qualities. For instance, owing to the elimination of capacity and inductance, it is specially suitable for measuring rapid-frequency currents.

CONTRACTS CLOSED.

MESSRS. SIEMENS AND ENGLISH ELECTRIC LAMP CO. LTD.: *London County Council;* renewal of contract for the supply of the whole of their requirements in Electric Incandescent Lamps for a period of twelve months.

Situation Vacant

ILLUMINATING ELECTRICAL ENGINEER required, capable of designing scientific reflectors and fittings for street, industrial and shop lighting, and fully conversant with their modern application. Must be able to prepare lighting schemes embodying best practice. Apply, stating age, experience and salary required to *The Illuminating Engineer*, 32, Victoria Street, London, S.W.

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

MODERN SUNLIGHT, *Vol. I, No. 3, May,* 1926.

The third issue of this new journal contains a variety of contributions on different aspects of the application of sunlight and ultra-violet rays, including " The Planning of an Ultra-Violet Clinic," by Eleanor and W. Kerr Russell; " Sunlight and the Slums," by Dr. R. King Brown; and " The Many Uses of Ultra-Violet Radiation " by a correspondent in Berlin. The latter refers to the interesting experience that milk yielded by cows bred and grazed on the sunny side of the high Alpine valleys is of better quality than that from cows bred and grazed on the shady side. There is also a note on the use of ultra-violet rays in tracking criminals, and a picture of family sun-bathing in Germany. Of special interest is the account of the cadmium photo-electric cell for measuring ultra-violet radiation. The need for a scientific test of intensity of these rays had long been felt, and the cell appears promising in this respect.

RUBBER AND ITS USES IN BUILDING WORKS. (*Published by the Rubber Growers' Association.*)

This little booklet, published by the Rubber Growers' Association, enumerates many of the practical applications of rubber. To most people rubber is primarily a product used for the tyres of motor-vehicles. But owing to its special elastic properties, it finds many uses in engineering work, for the seating of valves, for washers, and, of course, as one of the most important electrical insulating materials. From the builder's standpoint, its utility in the form of rubber linoleum is of special interest. Apart from its comfort to the feet and noiselessness, rubber floor-coverings have one important merit that should not be overlooked—their good insulating qualities. This is of special importance in bathrooms where the absorption of moisture by wooden floors is liable to cause ultimate trouble with wiring underneath; another incidental advantage is that it forms a natural insulator between the body and earth, and thus lessens the liability of shock from imperfectly protected switches, etc. In passing we may suggest one problem deserving of attention from the Rubber Growers' Association. To what extent is deterioration of rubber accentuated by exposure to light? Although good quality rubber has excellent lasting properties, it loses its elasticity in course of time. The slow deterioration of several materials has been traced to effect of exposure to light, especially ultra-violet rays, and one would like to know if rubber is similarly affected.

LA COUPE DES ACIERS AU CHALUMEAU, *A Practical Manual of Oxy-Acetylene Cutting.* (*R. Granjon, P. Rosemberg, A. Boutlé. Paris,* 1925; *pp.* 80; *figs.* 89; *price* 3 *fr.*)

This compact little booklet deals with oxy-acetylene cutting of steel. After a brief introduction, the selection of implements and material, the cost of the process and the detailed operations necessitated by various special forms of work (including cutting under water) are discussed. The information given is clear and practical, and the text is assisted by numerous well-executed illustrations. The book should be of considerable value to the worker in this field; whilst to the outsider it will give a good impression of the great variety of cutting processes that may be executed in this way.

ENGINES OF HIGH OUTPUT, *by Harry R. Ricardo, M.A.* (*Macdonald & Evans, London,* 1925; *pp.* 110; *figs* 38. *Price* 7*s.* 6*d. net.*)

This book originated in an analysis of the possibilities and limitations of high-speed petrol engines, prepared by the author during the war. Much further knowledge has subsequently been gained, and the present treatise, which deals more particularly with the thermodynamic side of the problem, brings things up to date. The book should prove interesting to all concerned with combustion engines who desire to study the fundamental principles of their design and the future possibilities of improvement.

A CONTRIBUTION TO THE STUDY OF THE HUMAN FACTOR IN THE CAUSATION OF ACCIDENTS, *by E. M. Newbold, M.A.* (*Report No. 34, issued by the Industrial Fatigue Research Board; published by H.M. Stationery Office;* 5*s. net; pp.* 74).

The detailed investigations described in this report all tend to emphasize the part played by individual susceptibility in many forms of accident; in other words, the chance of an accident differs for each person. The average number of accidents in a group may be influenced by a comparatively small number of workers. It is therefore necessary for companies to consider whether the conditions in a particular case affect all workers to the same degree, or whether special provision for a small number is called for. The report contains a considerable amount of statistical data. It is interesting to observe that the number of accidents tends to decrease somewhat with age, and that no consistent relation could be shown between accidents and output.

CUMULATIVE BIOGRAPHIC INDEX OF " PEOPLE IN THE NEWS."

We notice that *The Newspaper World* is publishing a new biographical or personal calendar monthly, containing a record of persons " in the public eye." The first issue for February contains notes of appointments and distinctions conferred on over 500 persons, classified in twenty groups, according to professions, etc. The index will doubtless be specially useful to newspaper men. The annual subscription rate is one guinea, and further particulars may be obtained from *The Newspaper World* (14, Cross Street, Finsbury, London, E.C. 2).

A NEAT UNIT FOR SEWING MACHINES.

As the lighting of sewing machines is a somewhat special problem, readers may be interested in a neat form of adjustable local unit, recently shown to us by the Photector Co. Ltd. Most experts consider that in dealing with very dark cloth strong local lighting is essential, though some degree of supplementary general lighting should not be omitted. In such local lighting two points are of primary importance—the local lamp should be completely screened from the eyes of the operator, and the fitting should be adjustable, in view of the necessity of careful regulation of the direction of light and elimination of any troublesome shadows cast by the needle. The unit we have examined terminates in a cup-shaped metal reflector completely concealing the lamp. The actual reflector and lamp can be swivelled, and the arm carrying it can be moved up and down. The lamp is controlled by a protected switch, and all bearing surfaces are lined with anti-friction material.

PERSONAL.

We understand that Mr. E. F. Darker, who recently represented the Benjamin Electric Limited in London, is now with the Electricity Department of the Cape Town Corporation.

This enterprise, which supplies a district of approximately 90 square miles, and has an output of 25,000 kilowatts, is under the able direction of Mr. Geo. H. Swingler, M.I.E.E., whose ability and resource is mainly responsible for the high standard of efficiency at which the station functions.

We hope Mr. Darker will, from time to time, furnish us with any items of interest regarding Cape Town activities in the electrical world.

We are informed that Capt. W. J. Liberty, Public Lighting Inspector of the City of London, having reaching the retiring age of 65, has resigned his appointment under the Corporation Pension Scheme, after nearly 47 years' service. Capt. Liberty is also known to our readers as the Hon. Secretary of the Institution of Public Lighting Engineers, and we wish him every happiness in his well-earned leisure.

ECONOMIES IN LIGHTING.

Sir,—The continuance of the coal strike has led to somewhat drastic measures for economy in lighting. Possibly by the time this letter is published there will no longer be any occasion for them. Let us hope so. But to those concerned with illuminating engineering the situation, which has much in common with that existing during the early period of the war, conveys several useful lessons.

In view of the anticipated shortage of coal during the war, possible measures of economy were examined very fully. It was shown at that time that the amount of fuel that could be saved by reasonable economies in lighting is minute. During the summer months, when comparatively little artificial light is used, the possible saving in the domestic field is almost negligible. Authorities in search of apparently simple measures are apt to favour the plan of asking consumers indiscriminately to reduce their amount of light by some specified fraction. This method is clearly unscientific, it penalizes the careful consumer, whereas the extravagant user of light may still be using too much. During any sustained period the plan of limiting consumers in terms of the permissible fuel for lighting and heating according to the number and size of rooms in the house is much fairer. This was ultimately adopted under the Household Fuel and Light Orders during the war.

From the standpoint of the electric supply undertaking, the preferable course is to eliminate so far as possible heavy peak loads; it seems doubtful whether the curtailment of commercial loads of factories, which now occur mainly during daylight hours, constitutes any very substantial economy—apart from its crippling action on business. On the other hand, users of display and advertisement lighting on a large scale may fairly be expected to be amongst the first to be asked to economize.

There is one form of lighting, that required for the preservation of safety and order, that should only be interfered with as a last resort. In fact, one might justly urge that it should be provided so long as supplies of gas and electricity hold out. One has only to recall the experiences during the great earthquake in Japan to recognize the great danger of a general failure of public lighting, both in destroying the sense of security and in causing complete cessation of traffic. It is sometimes argued that a diminution in public lighting is a good object lesson—a reminder to the public of the need for economy. But its influence in shaking public confidence is probably much more important; the impression that public lighting can be curtailed without grave drawbacks is an erroneous one that ought not to be fostered. Experts agree that at present most streets are still inadequately lighted in comparison with the traffic they bear. The maintenance of adequate light in the streets during any emergency should, therefore, be regarded as one of the first duties of the authorities. The chief lesson in this respect is the same as that learned by the authorities in Japan—to take every possible precaution to provide against interruption of this essential public service in the future.

Yours, etc.

ENGINEER.

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